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CONTENTS.

PAGE

The Vibration Produced by the Working of the Traffic on the Central London Railway. By CHARLES DAVISON, SC D., F.G.S. (*Illustrated*) 121

Across Russian Lapland in Search of Birds.—III. Forest, Lake and Marsh. By HARRY F. WITHERBY, F.Z.S., M B.O U. (*Illustrated*) 123

Vegetable Mimicry and Homomorphism.—III. By Rev. ALEX. S. WILSON, M.A., B.Sc. (*Illustrated*) 127

Astronomy without a Telescope. XIV.—Sunspots and Moonspots. By E. WALTER MAUNDER, F.R.A.S. (*Illustrated*) 129

The Belt and Sword of Orion. By ALEXANDER SMITH. (*Plate*) 131

Letters:

FAHRENHEIT'S THERMOMETER. By Sir SAMUEL WILKS, M.D., LL.D., F.R S. 131

THE VISIBILITY OF THE CRESCENT OF VENUS. By EDWIN HOLMES. Note by E. WALTER MAUNDER 132

THE USE OF HAND TELESCOPES IN ASTRONOMY. By F. W. LEVANDER 133

British Ornithological Notes. Conducted by W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U. 133

Notes 133

Notices of Books 135

BOOKS RECEIVED 137

The Nobodies,—A Sea-faring Family.—III. By Rev. T. R. R. STEBBING, M.A., F.R S., F.L.S. (*Illustrated*) ... 137

Microscopy. Conducted by M. I. CROSS. 141

Notes on Comets and Meteors. By W. F. DENNING, F.R.A.S. 142

The Face of the Sky for June. By W. SHACKLETON, F.R.A.S. (*Illustrated.*) 142

Chess Column. By C. D. LOCOCK, B.A. 143

THE VIBRATION PRODUCED BY THE WORKING OF THE TRAFFIC ON THE CENTRAL LONDON RAILWAY.

By CHARLES DAVISON, SC.D., F.G.S.

IN January, 1901, a Committee, consisting of Lord Rayleigh, Sir J. Wolfe Barry, and Professor J. A. Ewing, was appointed by the Board of Trade "to consider and report to what extent the working of the traffic on the Central London Railway produces vibrations in the adjacent buildings, and what alterations in the condition of such working or in structure can be devised to remedy the same." The report of the Committee was presented last January, and was followed in April by the publication of a series of appendices by Mr. A. Mallock, in which the details of the experiments are described. The present paper contains a summary of the methods employed by the investigators and of the results at which they arrived.

The Committee first heard the evidence of several residents near the line, who all agreed as to the objectionable character of the vibrations, and then ascertained by personal observation that their complaints were well-founded. As the disturbances arising from successive trains were found to vary much in intensity, concerted observations were also made by about a dozen persons stationed in different houses near the railway-line. Lastly, Mr. A. Mallock was deputed to make a careful study of the nature and extent of the vibration; and it is to his scientific insight and perseverance that the Committee attributes in great part the successful solution of the problem set before them.

Experiments were first made with a seismometer that recorded mechanically and magnified the movements of the ground or floor ten times. But, this being found insufficient, another instrument was used that recorded photographically and had a magnifying power of 75.

The principle of this instrument is the same as that employed in vertical-component seismographs. A weight is suspended by a spring from a support connected with the framework of the apparatus, and is so arranged that the period of the suspended weight is long compared with that of the vibration to be measured. When the ground or floor moves, the weight either remains practically at rest or its movement is shown on the record as long oscillations on which the rapid vibrations of the ground and point of support are superposed (Figs. 3 and 4).

The essential part of the apparatus is shown in Fig. 1.

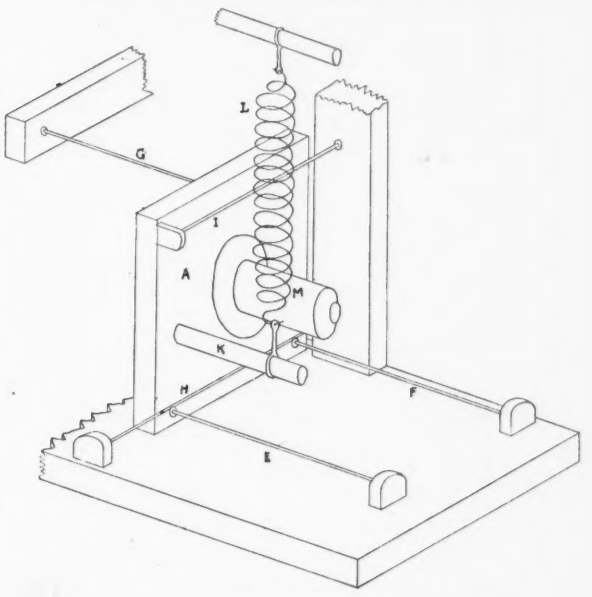


FIG. 1.

The weight A is a square plate of gun-metal, suspended by the spiral spring, L, which is attached, at the lower end, to the horizontal arm, K, projecting from the plate, and, at the upper end, to a support connected with the frame. Five steel rods, E, F, G, H, I, maintain the heavy plate in a vertical position. The ends of these rods are pointed, and one end of each rests in a conical steel cup on the plate and the other end in a similar cup on the frame. The rods E, F and G compel the plate to move only in its own plane, the rods H and I prevent it rotating or moving

horizontally in that plane, while the attachment of the spiral spring, L, to a point near the outer end of the eccentric arm, K, places all the steel rods in a state of longitudinal compression; so that, if the weight is displaced in a vertical direction, its return is resisted by the thrust of the rods. The resultant force tending to restore the weight to its former position depends, therefore, on the difference between the force exerted by the spring and the vertical components of the thrusts of the rods. By adjusting the point of contact of the spring and the arm K, this resultant force, and consequently the period of oscillation of the plate, can be varied at pleasure. It was found by trial that a period of about four-fifths of a second was long enough compared with the period of the vibrations to be measured, while a much longer period rendered the instrument too sensitive to changes of temperature.

The movements of the plate A with respect to the frame were registered photographically, in order to avoid the friction introduced by a mechanical recorder. For this purpose, a microscopic objective, M, one-sixth of an inch in focal length, was fixed to the plate with its axis horizontal. In its focus was placed a horizontal quartz fibre mounted on a stage, S, attached to the frame (*see* Fig. 2, the stage being omitted from Fig. 1 to simplify the diagram). Close to, but just short of, the conjugate focus of the objective, a vertical cylindrical lens, N, is fixed, and, the field of view being illuminated by a lamp at L, there appears in the focus of this lens a moderately bright

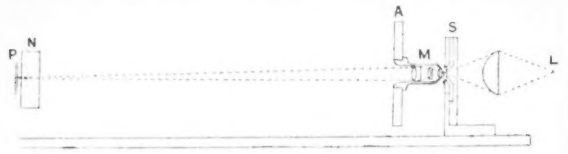


Fig. 2.

vertical line on which the image of the quartz fibre is cast as two black dots on either side of a very bright dot. The photographic plate, P, on which this image is received, was made to travel at the rate of about three-quarters of an inch a second; and the records on the negative, when developed, showed a dark line bordered by two narrow bands of nearly clear glass. The sensitiveness of the instrument may be judged from the fact that records are clearly given of every footfall of a horse when distant more than a hundred yards.

The vibrations in the ground are due to the passage of a heavy load over an uneven surface. If the wheels were absolutely circular and the rails perfectly straight and yielding uniformly throughout, there would be nothing to cause vibration.

In the Central London Railway none of these conditions is fulfilled. The rails are bridge rails in continuous contact with the sleepers, which are laid longitudinally and are bedded on concrete. This, however, varies in depth, being least over the flanges of the sections of the tube. In the intervals between the flanges, the yielding under a heavy load would therefore be greater than in the parts immediately above them, and this may in time cause a permanent unevenness of the rails.

But a far more serious cause of vibration lies in the fact that the rails, when first laid, are not straight. As they leave the rolls the rails are curved, and they are then bent under a press at intervals of two or three feet until they appear straight to the eye of the trained workman superintending the operation. This process naturally results in a slight waviness of surface, the average depth of the hollows being, as Mr. Mallock ascertained, about $\frac{1}{20}$th of an inch, and the average distance from crest to crest between $1\frac{1}{2}$ and $2\frac{1}{2}$ feet, though deeper hollows and longer waves are of frequent occurrence.

Again, the wheels, though nearly circular at first, wear irregularly owing to the action of the brakes, the slipping which takes place in travelling round curves, and possibly to variability in their material. A pair of wheels that had been in use for more than a year on the Central London Railway were found to be worn so that they were no longer concentric with the axles, and were also furrowed by minor waves.

There must thus be a continual variation of pressure between the wheels and the rails, and it is to this that the objectionable vibration is due. It is important to notice that the variation of pressure is not proportional to the total load on the wheels, but to that part of it which is not supported by springs. The part of the load which is spring-borne moves practically in a horizontal line without following the inequalities of the rails, so that there is no change of any consequence in the pressure corresponding to it.

The diagrams obtained by Mr. Mallock show that the vibrations of the ground caused by the passing trains are of many different periods. When, however, they are large and well-marked, the principal vibrations are found to be nearly constant in period, whatever be the speed of the train and however greatly the inequalities in the rails may vary in length. The reason of this is that the irregular impulses given by the uneven rail-surfaces set up an oscillation of the rails and the road-bed, which may be regarded as an elastic support loaded with that part of the mass which is not carried by springs.

Mr. Mallock remarks that a somewhat similar case is that of a ship rolling at sea. Whatever be the period of the waves, the period of rolling is very nearly that of the ship when it rolls in still water. It is only when there is a long succession of equal waves that the period of the rolling approaches that of the waves.

A few of the diagrams obtained by Mr. Mallock are given in Figs. 3 and 4. Those in Fig. 3 represent the vibration caused by an ordinary locomotive and train in No. 19, Hyde Park Terrace, the upper curve, *a*, showing the vibration in the basement, and the lower, *b*, that on the first floor. The vibrations caused by the train have a period of about $\frac{1}{15}$ of a second, and are, in both cases, superposed on longer waves due to the swinging of the heavy plate of the vibration apparatus. These diagrams show very clearly how much greater is the vibration on the first floor than in the basement of the building.

The series of curves in Fig. 4 were obtained on the ground floor of No. 13, Hyde Park Terrace. The first

FIG. 3.

three diagrams, *a*, *b*, *c*, represent the vibration caused respectively by an ordinary locomotive and train, a geared locomotive and train, and a multiple unit train. The last curve, *d*, shows the vibration of the same floor caused by a single light stamp of the foot. The effects of the different kinds of trains will be referred to afterwards. For the present it is worth noticing how much the vibration caused by stamping exceeds that due to any one of the trains.

The smallness of the objectionable motion is, indeed, one of the most remarkable results of the Committee's work. In the solid stone or floors in the basements and in the walls themselves, it was rarely found to exceed one or two ten-thousandths of an inch, and such vibrations, even if they recurred at the rate of fifteen per second, would in all probability escape notice. On the higher floors, however, the vibrations have an amplitude which may amount to, though it seldom exceeds, a thousandth of an inch, but it is these vibrations, when their frequency is over ten per second, that have given rise to such wide-spread annoyance.

From the last curve, *d*, in Fig. 4, it is clear why the vibration should be so much more marked on a floor than in the basement. We see that, after a single stamp, the floor makes quite a large number of oscillations before it comes to rest again; also, if we compare the curves *a* and *d* in the same figure, that the period of the floor's oscillations is very nearly the same as that of the principal vibrations caused by passing trains. Thus, vibrations, which in the basement are almost imperceptible, produce increased vibrations in the floors, just as one particular string of a piano resounds if the corresponding note be struck outside. How greatly the original vibrations may be magnified depends on the closeness between their period and that of the floor's oscillations, and on the slowness with which the latter die away. If the two periods happen to be nearly equal we may, therefore, expect a well-made floor to have larger vibrations set up by resonance than one in which the boards are unsound and the joists badly laid.

In the opening inquiry, nearly all the witnesses examined by the Committee stated that at times unusually severe vibrations were felt. As these might be caused by particular trains, simultaneous observations were made during one day in three houses from which complaints had been received. The observers were placed in different rooms and noted the times at which the vibrations were felt, and also estimated roughly their intensity, whether severe, moderate or slight. Others in the two adjoining

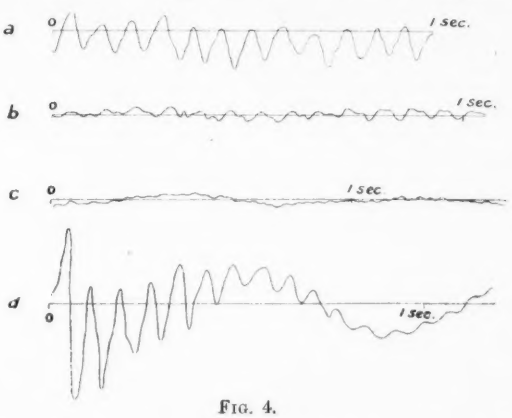


FIG. 4.

stations noted the times of arrival and departure of the trains, which were about 300 in number. The analysis of the observations showed: "(*a*) That it was a matter of chance whether a given locomotive caused a slight or a severe vibration; (*b*) That trains causing severe vibrations in one house were as likely as not to cause only slight vibrations in the others; (*c*) That different rooms in the same house were not similarly affected by the same train." Owing to the waviness of the rails and wheels, and to the random manner in which the irregularities of the wheels meet those of the rails, it is evident that there may be times when several pairs of wheels may be in a position to cause strong vibrations simultaneously.

When the work of the Committee began, the locomotives in use weighed forty-four tons, and the unspring-borne load on each of the four axles was eight tons. Two new types were constructed shortly afterwards, and were tested by the same methods. In the geared locomotive the total weight is thirty-three tons, and the unspring-borne load is reduced to two-and-a-half tons per axle; in the multiple unit train, the weight of the motor carriage is twenty tons, and the unspring-borne load is still further reduced to one-and-three-quarter tons per axle.

The effects of the different types of trains are well shown in curves *a*, *b*, *c*, of Fig. 4, which correspond to the ordinary locomotive, the geared locomotive, and the multiple unit train respectively. The vibrations produced by the trains are, in fact, roughly proportional to the unspring-borne load, for those due to the ordinary locomotive are more than three times as great as those of the geared locomotive, and more than five times as great as those produced by the multiple unit train.

The observations made on the different trains also prove that the locomotives are almost entirely responsible for the disturbances, for the passenger coaches were practically identical in all the trains, and the only vibrations that could, as a rule, be registered when the multiple unit train passed were those made by the motors at either end.

The chief practical results of the enquiry may therefore be summed up as follows:—(1) One method of lessening the annoyance would be to reduce the irregularities of the rail-surfaces; and, if a very high speed (say, of a hundred miles or more an hour) were ever employed, this improvement might become necessary. (2) But with the speeds at present customary, by far the simpler and more efficacious method is to reduce the unspring-borne load in the locomotives to less than two tons per axle.

ACROSS RUSSIAN LAPLAND IN SEARCH OF BIRDS.

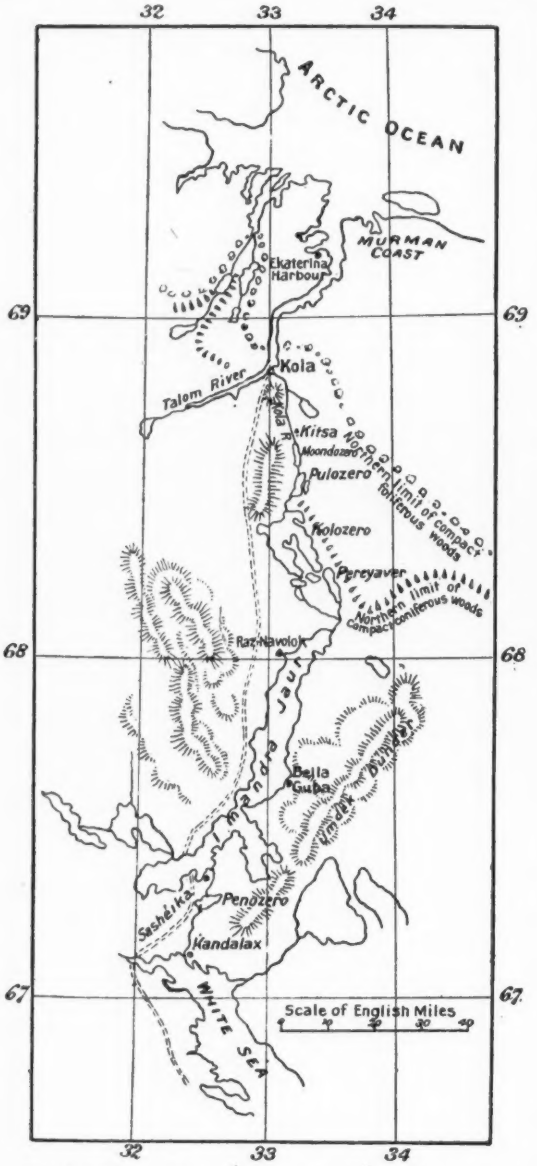
By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

III.—FOREST, LAKE AND MARSH.

OUR first camping place in Russian Lapland was charmingly situated on the shores of a little lake the surface of which sparkled brightly in the sun, while behind us the river shone white and foaming every here and there between the birch and pine trees. There were a good many birds about. The golden-eyed duck,* the most numerous duck in this country, and very good eating, was plentiful but not easy to get. One which we shot fell in the water, and being caught by the stream flowing through the lake was hurled down the river at a furious pace. One of our men ran after it, but returned perspiring in half-an-hour or so, saying that it must by now have reached Kandalax. The pretty three-toed woodpecker,† which is much like our spotted woodpecker, but has only three toes, and a yellow head, was common, and although apparently not nesting was often to be found in a hole in a tree. Like our woodpeckers, these birds no doubt roost in holes of trees, and as we found them in these hiding places at all times of the day and night, we came to the conclusion that in these regions birds, like men, take their sleep just when they feel they need it. Other birds were about all night—the familiar cuckoo‡ was often to be

* *Clangula glaucion.* † *Picoides tridactylus.*
‡ *Cuculus canorus.*

heard at midnight, and Siberian jays* would wake us up with their harsh cries at one or two in the morning. These jays were not so large or so brightly coloured as the birds which worry our game-keepers at home, but they were most amusing. They used to come round our tent door while we were asleep and fight over the carcases of birds which had been skinned. Like English jays they were fond of imitating the notes of other birds, and one night



Sketch Map, showing route across Russian Lapland from Kandalax to Ekaterina Harbour.

we were waked up by a loud cry like a hawk. My friend snatched up his gun and, creeping to the tent door, shot the bird. Regardless of mosquitoes he went out with bare feet to pick up the "hawk." The mosquitoes drove him back at a run in no peaceful state of mind. "What was it," said I. "Jay," said he rubbing himself all over and beating the mosquitoes out of the tent with a towel. When the tent was clear and the mosquito curtain adjusted, I endeavoured to console my friend with the suggestion that the jay had fully atoned for its misplaced facetiousness.

As already explained we were forced to hurry through the country rather more quickly than we had wished owing to the difficulty of transporting and obtaining food. Had we not set our men to work to fish on every possible occasion, and had we not shot every eatable bird we could find our time would have been considerably shortened.

Luckily for us a certain amount of fish was always obtainable, and we made many a meal off salmon and salmon trout. It will shock the scientific fisherman to hear how we caught our fish, but we were not ashamed of poaching tricks because our time was fully occupied with collecting birds, and when we fished food was our only object and the quicker it was obtained the better. For instance, there were a fine lot of salmon in the little lake by which we first pitched our tent. As we rowed along this lake on our way north a line with a minnow at the end was let out. We soon had a 15 lb. salmon on, and he was quickly hauled alongside. We had no gaff handy, but a sheath-knife answered the purpose, and certainly the fish tasted very well when we fried him a few hours afterwards.

At the other side of the lake the river, swollen by melting snow and ice, was rushing down in a torrent so that we had to land and walk. While our men were loading up we found a lovely little dome-shaped nest of a willow-wren,* which is familiar in England as a summer resident, and is a great traveller for so small and slender a bird. The track, which led through very marshy ground, was composed of wooden "trottoirs," made of split logs laid down side by side. Wherever there was a track across boggy land in this country it was always made in this way, and when the logs were new walking was easy, but as often as not the logs were rotten or insecure. A loose log was annoying, and difficult to walk along gracefully, because the rounded side was laid on the ground, and an incautious step made it turn, and then there was disaster, especially when the bog was deep. At first we were always coming to grief on these "trottoirs," and our heavily loaded carriers disliked them exceedingly, although they were always quick to make merry over the misfortunes of others. However, experience teaches one even to walk along rounded planks over a marsh in safety, and in any case we consoled ourselves with the idea that these bogs were frozen not far below the surface. That such was the case we doubted afterwards, when several places had been tested unintentionally, and no bottom could be discovered.

During our first little walk over these "trottoirs" we saw many bramblings† in the birch trees about the track. These birds are only known in England in the winter, but in the north they may be said to represent the chaffinch, being very much like that bird in form and size, as well as in habits. The nests of the birds are almost identical, although perhaps the brambling's is not quite so neat as that of the chaffinch, while their notes are much alike. Another bird which continually reminded us of England was the red-spotted blue-throat.‡ This bird takes the place in these regions of our robin, to which it is nearly allied. It is very robin-like in its attitudes and movements, but instead of the red breast it has a shining blue throat with a red spot in the middle of the blue. This red spot distinguishes the northern blue-throat from

* *Perisoreus infaustus.*

* *Phylloscopus trochilus.* † *Fringilla montifringilla.*
‡ *Cyanecula suecica.*

its southern representative, which bears a white spot on its blue throat. The young bird has no blue on the throat, and its brown spotted plumage is much like that of a young robin.

Our walk ended on the shores of another small lake—the Penozero. Crossing this and marching again, this time through a pine forest, we reached Sashéika, where there is a "station" of two or three huts at the southern side of the great Imandra Lake. We were told here that the ice had cleared from off the lake only five days before we arrived (viz., on July 4th), so that all our delays counted little because we could not have proceeded further until the ice had left the lake.

At Sashéika we came across the first Lapps we had seen in this country. There were two very small men with fair hair and fair skin and two women with rather dark complexions. They lived in a small turf hut of the meanest

A Lapp Hut made of Turf.

description. During our journey across Russian Lapland we saw very few Lapps, as they leave the interior of the country during the summer and proceed to the coast for the fishing. At two places we found large Lapp villages of wooden houses entirely deserted. During this time of the year the reindeer are turned adrift, and most of them find their way to the coast or to high ground in order to escape from the swarms of mosquitoes which make the interior of the country unbearable for man or beast during the summer.

The few people we saw, whether Lapps or Russians, and the few animals, such as a dog or two and one cow, were utterly miserable owing to the mosquitoes and biting flies, and it is not surprising that the country is deserted even for this reason alone. The Lapps appeared to live almost entirely on fish and a sort of bread which is made from pounded birch bark with a mere sprinkling of flour. No vegetables can be grown in the country, and it is possible that this birch bark bread serves as a substitute. The huts of these people are extremely dirty, and those we examined were always strewed with fish bones and old reindeer horns.

Finding very few birds about Sashéika we soon decided to leave, and loading our baggage and ourselves into a small boat we started up the great lake, rowed by two men and two Lapp women, and steered by a Lapp man. We had got well into the middle of the lake when a thick fog came down and every landmark disappeared.

None of us wished to wander about the lake for hours in the fog, and the old Lapp at the rudder was sure he could steer to the shore, but no land appeared, and we soon discovered by a fishing line which we had out astern that his course was by no means straight. After a search in the baggage we found a compass which showed much to our amusement that the boat was describing circles. We tried to explain this to the Lapps, but they did not understand a compass. The fishing line, however, convinced all, except the old man who was steering, that we were not going straight. He was perfectly certain that he knew where he was going and refused to give up the rudder. Everyone in the boat began shouting directions to him, and it was some time before we could calm the people down and induce the old man to give up the rudder. As I knew that we wanted to go somewhere north I thought it safest to steer due north, and in about half an hour we reached the shore. As luck would have it there was a large rock which the Lapps immediately recognised just where we struck the land. It appeared that we had come on in the right direction, and even the old Lapp looked on me with suspicious awe.

According to Gregori they thought the rock was marked on the compass, but I rather think they suspected magic, because they could not understand how anyone could steer, especially in a fog, without a previous knowledge of the country.

While the fog lasted we spent the time in sleep, and the next day we rowed on and reached Bella Guba, where there was a telegraph station, a post house, and one other house, besides a few Lapp huts. Along the shores of the Imandra, ringed plovers* were nesting, while a few other birds such as Arctic terns and gulls, generally seen by the sea, were flying about. The dense pine forests which stretched away from the lake to the rocky hills beyond were distressingly destitute of bird life. Now and again one would catch sight of a capercaillie,† a Siberian jay, or a pine grosbeak,‡ but a walk in this dreary forest yielded little to compensate one for the torments inflicted by the mosquitoes. There were a few islands in the lake, but these were unproductive of birds, and we found that the marshes and the country just round them were the only really profitable places in which to spend our time.

We visited every marsh we could find or hear of near our route, and it was curious that while most of them contained many interesting birds, every here and there was one which was practically deserted, although apparently it differed in no way from the others.

All travellers in Lapland have something to say about biting flies, while a few in relating their experiences have been so led away by the subject that they have devoted a full two-thirds of their narratives to descriptions of mosquitoes and flies. Caution is therefore necessary in dealing with so tempting a subject, and I shall endeavour to confine my remarks on these interesting insects to the effect they had upon our work with the birds. Walking anywhere in a damp hot climate is somewhat of an effort, and soft mossy ground like most of that we had to travel over is notoriously tiring. Add to this the necessity of wearing continually thick gauntlets and a mosquito veil, and the conditions are not pleasant. But it was on the marshes that we were chiefly tried. There, mosquitoes and flies were in clouds, the damp heat was increased, and one sank knee-deep in moss and mire at every step. Under these circumstances, it will be understood that it took us

* *Aegialitis hiaticula.* † *Tetrao urogallus.*
‡ *Pinicola enucleator.*

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some time to explore a marsh thoroughly. We shall never forget one awful day, just before a heavy thunderstorm, when we attempted to work a marsh, but found it quite impossible to go more than twenty yards without resting. A veil is a great handicap in shooting, and we found it exceedingly difficult to judge distance at all accurately. As to trying to watch birds in this country it was impossible to do so for any length of time. Directly one stopped, such a cloud of mosquitoes gathered round one's head that after a short time the bird could not be seen through the binoculars owing to the dense swarm of mosquitoes which quickly gathered in front of the glass.

The only times in which we were able to discard our veils was after we had beaten the mosquitoes out of the tent and fixed the curtain over the doorway, and when after rowing hard for half an hour or so on a lake we left the mosquitoes behind. At one place, however, we met a tiny black fly in such myriads that it became a far worse pest than the mosquitoes. This fly was so small that no ordinary netting would keep it out, and it crept into our hair and ears and bit so hard and unpleasantly that to escape going mad we were forced to pack up our things and run away from the place. But no one who has been in the interior of Lapland in summer can adequately describe the blood-sucking insects which possess that country.

As I have mentioned, the birds found on the marshes or bogs were the most interesting. They were chiefly wading birds, and many of them were well known to us as autumn

A Lake in Russian Lapland.

and winter visitors to the shores and mud-flats of the English coast. The most common of these were whimbrels* and wood sandpipers,† while greenshanks‡ and reeves,‖ although not so numerous, were to be found on most of the marshes. All these birds appeared to have young ones, and in different ways showed intense anxiety for the safety of their broods. The whimbrels and greenshanks were always shy and cautious, keeping at a respectful distance and uttering loudly and incessantly their wild clear notes. It is remarkable that all these wading birds, when at their breeding stations habitually perch on the trees. The whimbrels used to perch on the tops of the fir trees, and fluttering their wings, perhaps to help keep their balance, would whistle defiantly at us. In the same way all the wading birds we found perched on the trees when disturbed.

Every marsh, and indeed every little bit of marshy ground, had a pair or two of wood sandpipers. Most fussy and noisy little birds they were, and so bold and tame that when once disturbed they were difficult to get rid of, and would follow one about so closely, crying anxiously all the while, that one's presence soon became known to every other bird anywhere near. It was curious that although reeves were as tame and almost as plentiful in some places as wood sandpipers, we never saw a single ruff, as the male bird of this species is called. The ruff is polygamous, and it is well known that it keeps apart from its harem when the young are hatched, and takes no share or responsibility in the troubles and anxieties connected with its offspring. Had there been any ruffs in the country we explored, I think it hardly likely that we should have missed them, so we must conclude that they had entirely deserted their families and had already gone south towards their winter quarters.

From Bella Guba we rowed up the Imandra to Raznavolok near the northern end of the lake, and on some marshes near there we made our best finds. Hitherto we had found birds in this country by no means plentiful, and we had been much disappointed by the dearth of bird-life in the enormous pine forests as well as on the large lakes. We were delighted, therefore, to find a great many interesting birds breeding on these marshes. Two of these, the bar-tailed godwit* and the dusky redshank,† especially attracted our attention, because it had been the privilege of but a very few ornithologists to see these birds in their breeding haunts. On arriving at the largest marsh, which was a five-mile trudge from our camp, we arranged to work it systematically. However, we had scarcely gone a hundred yards before a strange bird rose from the ground. We shot it and found with delight that it was a male bar-tailed godwit in the beautiful summer plumage—a dark black-brown back and a rich salmon pink breast. A long search near the place from which the bird had risen was unproductive—neither its nests nor the eggs or young could be found. Then we began to search the marsh rather excitedly, and some way off we put up the female—not nearly so brilliant a bird, with a buff rather than salmon-coloured breast. Still we could find neither eggs nor young, but at this we were not very surprised, as these marshes or bogs are profusely overgrown with a multitude of creeping plants, such as dwarf birch and many kinds of berry-bearing plants besides thick moss and grass. That day we found many other birds but saw no more godwits. On the next day, however, we carried out our plan of a systematic search and were successful in finding two more pairs of godwits. The male bird of one of these pairs was evidently in charge of young ones. He flew round us in a very excited way, and although he did not hover about quite near us, like the sandpipers and reeves, he often swooped over our heads with a rush and then retired to a tree-top and quivered his wings and called loudly. We kept as quiet as the flies would allow, and after a time I saw four young birds running on the ground at some distance. I rushed madly to them; they separated, and I managed to keep only two in view. These I caught, but the other two had hidden themselves so cleverly and quickly that although we knew just where they must be we could not discover them, and of course nothing would make them budge now that danger threatened. Young birds which run as soon as

* *Numenius phæopus.* † *Totanus glareola.* ‡ *Totanus canescens.* ‖ *Machetes pugnax.*

* *Limosa lapponica.* *Totanus fuscus.*

they are hatched know well the value of lying flat and keeping as still as stones. My friend afterwards found a brood on another marsh, but these he failed to catch. In each case the male bird was evidently attending to the young as the female was found at some considerable distance. These young godwits were only a few days old, and were beautifully clothed with soft down. They were great prizes, and, as far as I know, were the first young in down of the bar-tailed godwit to be obtained, although Mr. H. L. Popham has told me that he had seen them on the Yenesi in Siberia but had been unable to secure any.

The dusky or spotted redshanks which we discovered on several marshes were an even greater find than the godwits, because since the days of Wolley, fifty years ago, our knowledge of their breeding haunts has scarcely increased. Unfortunately, however, we were unable to discover either eggs or young of these birds notwithstanding hours of watching and searching. One day I watched a pair for two hours without success, so wary were the birds. When I was in view they flew wildly about uttering an incessant rattling alarm note. Then when I got well hidden they kept quiet, and my hopes of their visiting the nest or young revived. I waited. Meanwhile the mosquitoes gathered in thicker and thicker swarms. My veil getting disarranged touched the back of my neck, and immediately a cluster of mosquitoes settled on the place. A slight exclamation and an incautious movement were impossible to prevent, and the ever-watchful redshanks saw me and began their fuss and clamour again. I had to change my hiding-place and wait again, but the mosquitoes and the redshanks always got the best of it in the end, and at last I came to the conclusion that my patience was insufficient for the task.

The majority of wading birds have a larger and richer plumage in summer than in winter, and these redshanks were of a very handsome sooty-black colour spotted with white. Their beaks were dark, but their legs were of a rich crimson, which looked very bright against their black breasts.

To find these two species in their breeding haunts was especially interesting to us, because both birds visit the shores of England on their migrations in spring and autumn.

VEGETABLE MIMICRY AND HOMOMORPHISM.—III.

By Rev. ALEX. S. WILSON, M.A., B.Sc.

QUITE a number of flowers have distinctly mimetic odours. It can hardly be doubted, for example, that the offensive smell of the carrion flowers *Stapelia*, *Aristolochia*, *Arum*, *Rafflesia*, and others, is more effective in promoting cross-fertilisation because of its resemblance to the odour of putrid meat. So completely are the flesh flies deceived that they often deposit their eggs on the petals of carrion flowers.

Fœtid odours occur in *Bryonia*, *Helleborus*, *Geranium*, *Stachys*, *Ballota*, *Iris*, and other genera. The odours of others have a curious resemblance to the smells emitted by certain animals. *Hypericum hircinum* and *Orchis hircina* are bad smelling flowers with an odour resembling that of the goat; *Coriandrum sativum* has the fœtid smell of bugs, while the hemlock, again, emits a strong odour of mice. Along with these may be mentioned *Adoxa*, the musk orchis, the grape hyacinth and other musky scented flowers.

The resemblance in smell between these flowers and the secretion formed in the scent glands of the musk ox and other animals is, to say the least, a remarkable coincidence. Possibly flies which accompany cattle may be attracted by smells of this description. Very curious also is the vinous smell of *Œnanthe*, and the brandy-like aroma of the yellow water lily *Nuphar*, hence called the brandy bottle. Ethereal oils exhaled by plants while attractive to some animals seem to repel others; the scents of sweet-smelling flowers such as *Daphne*, *Thymus*, *Marjoram*, *Melilotus*, and *Gymnademia*, though grateful to bees and butterflies, appear to be distasteful to ruminants. Kerner states that in general the latter avoid all blossoms; even caterpillars do not readily attack the petals of their food plants. Odour may therefore be protective or attractive or it may be of use in both ways. The same remark applies to colour, which may serve either to attract or repel; the richly-variegated leaves of the Indian nettles—species of *Colleus*—and the tinted foliage of *Begonia* and *Geranium* may possibly escape injury on account of the general resemblance to coloured blossoms. Instances in which one plant resembles another in smell are not very common in the flowering class, though cases do occur like the garlic mustard and apple-scented *Salvia*. Resembling odours are much more frequent among fungi.

Characteristic examples of homomorphism are seen in the resemblances which many species of Euphorbia present to the Cactus tribe and in the pollen-masses of the Orchids and Asclepias. In Britain the order Euphorbiaceæ is represented by the box, dog's-mercury and the sun-spurges, but many foreign species have quite a different appearance and agree with the Cacti in their

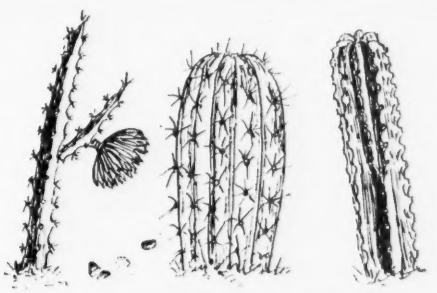


FIG. 10.—Cactus and Euphorbia.

aborted leaves and green succulent stems. The globular, columnar, and angular forms give to both a peculiar aspect by which they are broadly distinguished from all other vegetable types; and yet in systematic position these two orders stand far apart. The nearest affinities of the Euphorbiæ are with the Urticaceæ and other orders having incomplete flowers, while the nearest allies of the Cacti are the Cucurbitaceæ and other calyciflora orders. Succulent stemmed plants of this description are specially adapted to an arid climate, and it is not unreasonable to suppose that the similarity between the Euphorbiæ and Cacti results from the long-continued action of similar external conditions upon similarly endowed tissues.

Sir W. T. Thiselton Dyer, in a paper on "Mimicry in Plants" (British Association, 1871), adduces as examples of homomorphism, or as he terms it, homoplasm, a climbing composite of South America, *Mutesia speciosa*, having the leguminous habit and closely resembling the European *Lathyrus maritima*; three ferns, natives of different parts of the world, which are indistinguishable in the barren state; and a species of Veronica in New Zealand; the latter so resembles a coniferous plant that it misled Sir W. Hooker.

The Australian Casuarinas are dicotyledons with incomplete flowers nearly related to the oak, hazel and other Cupuliferæ, but in outward appearance they have a singular resemblance to the horse-tails, a family of Cryptogams. One of the Gymnosperms or cone-bearing class, Ephedra, also presents the same jointed appearance so characteristic of Equisetaceæ. Growing in marshy places very like those affected by Equisetum we find the mare's-tail Hippurus, a flowering plant allied to the fuchsia family, but externally resembling Equisetum in its jointed stem and whorled leaves. A familiar instance of the same kind of homomorphism is Equisetum sylvaticum, which might almost be described as a Lilliputian fir-tree. The little flowers of the water ranunculus look exactly like miniature water lilies, while the leaves and flowers of Caltha palustris simulate the yellow Nuphar so much that in some parts of the country the marsh marigold is known as the water lily. The specific name of another aquatic, *Lymnanthemum nymphæoides*, indicates a peculiarity of the same kind. Leaf analogies are frequent among aquatic plants; the orbicular, peltate leaf of the Indian cress occurs, for example, in Hydrocotyle, Nelumbium, and others. The brown colour and translucence of Potamogeton, Myriophyllum, and other aquatics assimilates them to the fronds of Laminaria and other sea-weeds.

A grass-like habit is assumed by some plants. This character is attained in the meadow vetchling by the arrested development of the compound leaves and the great elongation of the stipules. *Lathyrus nissolia* has the stipules minute, but the phyllodes or leaf-like petioles impart the grass-like character. A moss-like habit occurs in a great many plants belonging to very different families; thus the wiry stem of the purging flax reminds one of the seta of Polytrichum. The pearlwort of the walls, many alpine saxifrages, pinks and gentians present very much the appearance of mosses, *e.g.*, *Silene acaulis*, *Saxifraga bryoides*, *S. hypnoides*, *Arenaria Cherleri*, etc. The sub-species Saxifraga geum is another instance of leaf analogy. The generic name Pyrola implies a fancied resemblance of the leaves to those of the pear tree. Certain leaf-types frequently recur, the rough broadly tongue-shaped leaf of the bugloss, for example; hence the very common specific appellation *echioides*. The nettle-leaved bell-flower reproduces the foliage of Urtica and the sinuate leaf of the oak appears in several families.

Parasitic phanerogams like Rafflesia commonly exhibit the fungoid character in a marked degree. In their internal structure, colouring, spore-like seeds and other characters they approximate closely to the fungi.

As examples of homomorphism between closely allied plants may be mentioned the false oat, which so strikingly resembles the cultivated species, and the barren strawberry which agrees so closely with the cultivated strawberry of our gardens.

Although it is only under exceptional circumstances that a flower is likely to mimic another blossom closely, vague general resemblances are not uncommon, such as that between the rock-rose and the buttercup, between the milkwort and the vetch, and between Veronica and Valerianella. A more decided likeness is that of the garden annual Collinsia to the butterfly blossoms of the pea tribe. This case is peculiarly instructive since the homomorphism can be traced to its cause. The butterfly-like corolla of Leguminosæ seems to have afforded the pattern after which a number of flowers have been fashioned. The Papilionaceæ are adapted to bees rather than to butterflies or moths, and the pollen is applied to the ventral surface of the insect, the essential organs being lodged in the carina or pouch formed by the two lower petals. Among the Scrophulariaceæ to which Collinsia belongs, the pollen is commonly sprinkled on the back of the insect and the stamens are contained in the upper lip of the corolla; Collinsia is, however, exceptional; the stamens are lodged within the lower lip of the flower and the pollen is applied to the ventral surface of the bee. Here the resemblance is evidently an indirect result brought about by the flowers of Collinsia having become adapted to the same class of visitors as the Papilionaceæ, viz., bees which have their brushes or baskets of hair for collecting pollen attached to the abdomen. Where two flowers are very like insects are apt to mistake the one species for the other, but this will not involve any loss if there is an interval between their periods of blossoming.

Homomorphic likenesses are not confined to homologous organs; an organ of one plant sometimes exhibits a very perfect resemblance to a different organ on some

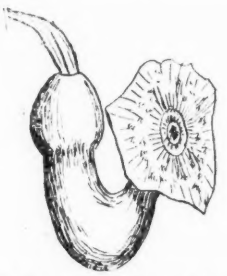


FIG. 11.—The Dutchman's Pipe *(Aristolochia sipho)*.

other plant. Thus *Aristolochia sipho*, the Dutchman's pipe, so-called from the appearance of its flowers, has a perianth singularly like the leaf-pitchers of Nepenthes, and the curious little nectaries of Nigella might almost be compared with the pitchers of the Australian insectivorous plant Cephalotus. As the Aristolochias imprison small dipterous insects in their flowers these instances favour to some extent Henslow's idea that

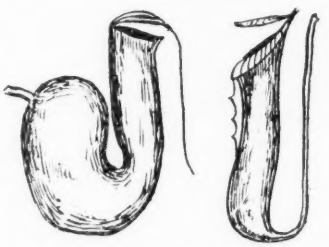


FIG. 12.—Flower of *Aristolochia trilobata* and Leaf-pitcher of Nepenthes.

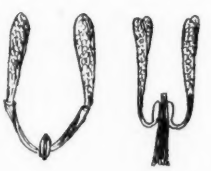


FIG. 13.—Pollen-masses of Orchid and Asclepiad.

both flowers and pitchers have arisen by hypertrophy caused through the irritation set up by insects.

The homomorphism of the Orchids and Asclepiads is specially interesting because of the objection to the Darwinian theory that it presents; the coincidence is certainly unfavourable to the notion of fortuitous variation. The orchids and asclepiads agree in producing pollinia or pollen-packets which attach themselves to the bodies of insects and are thus transferred from flower to flower. Although the two flowers differ greatly in

the details of their structure, this curious contrivance occurs in no other plants, and yet the two orders are as widely separated as it is possible to conceive. The orchids belong to the petaloid division of Monocotyledons; the Asclepias to the gamopetalous Dicotyledons, with their nearest allies among the Apocynaceæ, of which Vinca, the periwinkle, is perhaps the best known representative. Although agreeing in this one particular the flowers are in other respects very dissimilar.

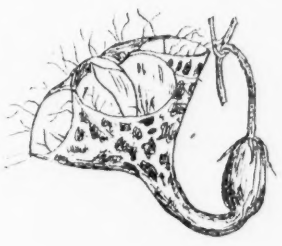


FIG. 14.—Flower of Ceropegia.

FIG. 15. — Birthwort and Cuckoo-pint showing mouse-trap hairs.

Another contrivance for promoting cross-fertilisation met with in unallied plants is the mouse-trap arrangement of hairs by means of which small flies are temporarily imprisoned. This arrangement occurs in Aristolochia, in species of Arum, and in Ceropegia, one of the Asclepiads. In these plants where the affinities are so slight the mechanism for fertilisation must in each case have arisen independently.

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

XIV.—SUNSPOTS AND MOONSPOTS.

THERE are only two of the heavenly bodies which present a disc to our ordinary sight, and the surfaces of which therefore we can study without a telescope. These are the sun and moon. It is, of course, absolutely impossible that observations thus made can in any way compete with those made even with a hand-telescope; but from the point of view of astronomical drill, as distinguished from actual research, there is something to be said for systematic work upon both of them. Jupiter as seen with a magnifying power of 50, Mars at a mean opposition with one of 100, Saturn with a similar magnification, present about the same apparent disc as the sun and moon do to the naked eye. There is therefore a real interest in seeing how much detail the eye can actually detect upon these two bodies. The limit of magnification possible for the efficient study of the surfaces of the planets is soon reached, and when an astronomical artist has done his very best with Jupiter, Mars, Saturn or Venus, it would be an invaluable check upon his work if he would draw the sun or moon with a little instrument, and such small magnification as would give to its disc the same apparent diameter as had been presented to him by the planet which he had just been studying. The "Bulletin de la Société Astronomique de France" for 1900 contains a large number of such drawings of the moon, made with the naked eye, and the study of them is, I think, most instructive on a number of points which have been in dispute from time to time as to the condition of the surface of Mars.

The defining power of the eye is, of course, limited, and when a number of details are presented to it, each one of which is much too small to be defined separately, all together produce a composite effect to which each detail has contributed in its own degree. Now there certainly is a wide

NORTH.

EAST. WEST.

SOUTH.

Photograph of Moon, taken 1902, March 22, 10h. 37m. 24s. G. M. T.

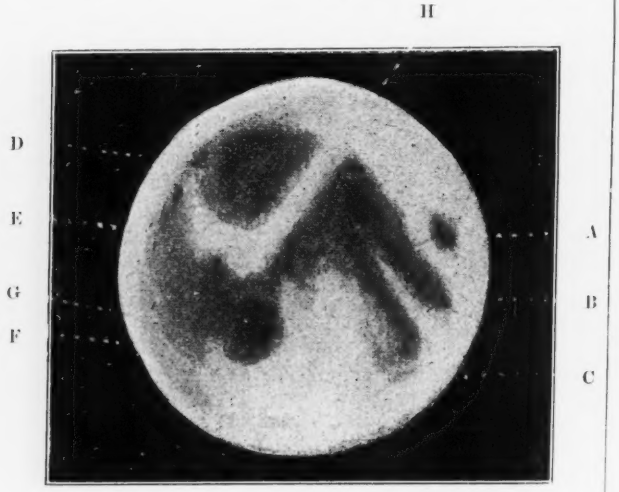
difference in the manner both in which such composite effects will impress different persons, and in the way in which they will record them in a drawing. And the study of the "personality" of astronomical artists should be a necessary precedent of the comparison and collation of their drawings. The drawings of the moon, given in the volume referred to above, are as widely different as any set of drawings that were ever made of Jupiter or Mars. Yet a careful comparison of them with maps or photographs of the moon will show that the forms given are not imaginary, but have a real relation to the lunar markings, whether they be skilfully represented or no.

The following drawings are from the volume cited, pages 277 and 505, and are by M. Maurice Petit and M. E. M. Antoniadi respectively. The latter comments on his observations as follows:—

> "It is a work of immense difficulty to draw correctly all the "details that the naked eye reveals to us on the surface of our "satellite. It is above all things necessary that the moon should "be seen with the greatest possible distinctness. If the eye is not "emmetropic it will be necessary to select glasses of the proper "focus bringing the focus *exactly* on the retina. The accom-"panying sketch which is only a rough approximation was obtained "with concave glasses, allowing at least ten stars to be seen in the "group of the Pleiades; it is the result of studies covering several "lunations. . . . . The darkest spots seemed to me (1), the Mare "Tranquillitatis, and (2) Mare Nubium. The Mare Serenitatis and "Fecunditatis come next. Mare Imbrium and Oceanus Procel-"larum are still paler. The little Maria Crisium, Vaporum, Humorum "and Nectaris, are reduced in size by irradiation, and present to the "naked eye an appearance corresponding to that of the Lacus Soli-"and Lacus Lunæ of Mars as seen in a telescope. The white spot-"of Copernicus and Kepler are very well seen, Aristarchus with "more difficulty, whilst Tycho, with its brilliant surroundings, "occupies an immense white surface; but . . . . the ring itself "is not seen. Gueriké, Bonpland, Parry and Fra Mauro make up

"a bright island in the Mare Nubium Lastly, the Mare Serenitatis "is whiter in the centre by reason of the great white streak coming "from Tycho which crosses it."

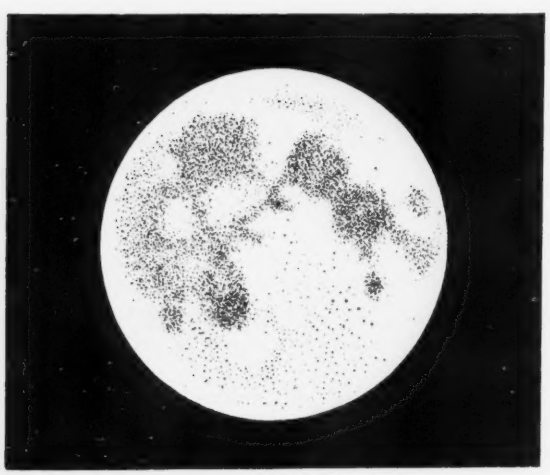
With regard to the sun, it may be thought that absolutely nothing can be done without optical assistance. But any



A, Mare Crisium. B, Mare Foecunditatis. C, Maria Nectaris et Tranquillitatis. D, Mare Imbrium. E, Oceanus Procellarum. F, Mare Humorum. G, Mare Nubium. H, Apennines and Copernicus.

Drawing of M. Maurice Petit.

observer who will give himself day by day to its patient scrutiny will be astonished ere long at the result. Of course, in this case, the term "naked eye" is no longer applicable, since the eye must be shielded from the overpowering light of the sun either by a dark glass or the sun's light may be admitted through a small hole into a darkened chamber and received upon a white screen. But thus observed the sun at maximum activity will show a spot large enough to be *easily* seen on fully one day in

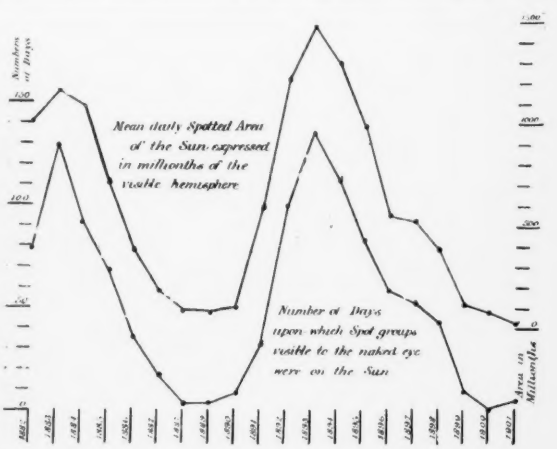


Drawing of M. Antoniadi.

four; not infrequently two or three spots may be seen at the same time. Had it occurred to the classical and mediæval astronomers to watch the sun systematically in this way, they would not only have detected the existence of spots on its disc, but have demonstrated as certainly as we know it to-day the period of the sunspot cycle, and the value to us of that information would have been incalculable. More than that, it would have been possible for them, from a long series of observations, to have fixed the solar rotation period fairly exactly and to have made a first approximation to the determination of the position of the axis.

The accompanying little table and diagram give a comparison between the number of days in each year during the last two decades in which there were spot groups the

Year.	No. of Days on which Spot-groups exceeding one-thousandth of the Sun's disk were visible.	Mean daily spotted area expressed in millionths of the Sun's visible hemisphere.
1882	78	1002
1883	129	1155
1884	91	1079
1885	68	811
1886	35	381
1887	17	179
1888	3	89
1889	3	78
1890	8	99
1891	32	569
1892	99	1214
1893	135	1464
1894	112	1282
1895	82	974
1896	58	543
1897	52	514
1898	42	375
1899	9	111
1900	1	75
1901	5	29


Numbers of Days
Mean daily Spotted Area of the Sun expressed in millionths of the visible hemisphere
Number of Days upon which Spot groups visible to the naked eye were on the Sun
Area in Millionths

area of which as seen covered more than one-thousandth of the sun's apparent disk, and the mean daily spotted area expressed in millionths of the visible hemisphere as deduced from the photographic record at Greenwich. It will be seen that the first record comes as sharply to a maximum as the second, and falls off again as unmistakably to a minimum. Even the minor details of the second curve are faithfully indicated in the first. The limit chosen—one-thousandth of the visible disc, or almost

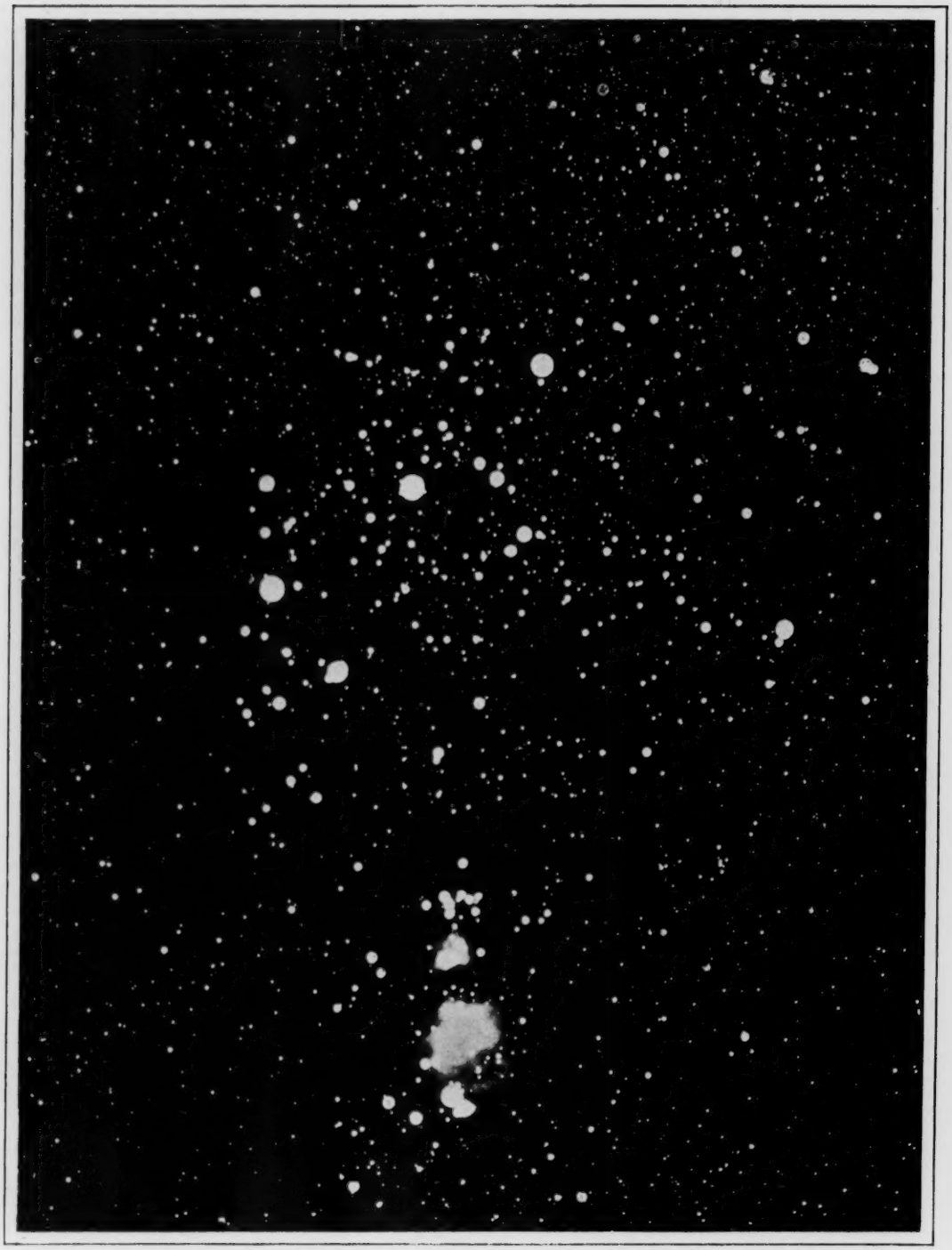
XUM

XUM

XUM

NORTH.

EAST.



WEST.

SOUTH.

PHOTOGRAPH OF THE BELT AND SWORD OF ORION.

Taken by A. Smith, Dalbeattie, on 2nd February, 1902. Exposure 2 hours 40 minutes.

XUM

XUM

exactly the apparent size of Venus in transit—would not in all cases correspond precisely to the limit for the visibility of spots. Specially dark and compact spots have been distinctly seen even when only of one-half this size; faint or scattered groups might escape notice even if a little larger; but general experience has shown that the limit selected corresponds very nearly to the limit of visibility without optical assistance, differing from it in under-stating, not over-stating, the number of groups which could be seen.

Of course, there is no possibility now for the "Astronomer without a Telescope" to improve on the information which the telescope can give us as to solar physics, but the lesson which the foregoing table has to teach is a most important one. Observations, as difficult and as apparently hopeless as observations of the solar surface would have seemed to be in the Middle Ages, may, if carried out patiently and systematically, bear as rich fruit as solar observations could have done even then. Even after the invention of the telescope, it was not the optical power of his instrument, but the perseverance with which he worked at a single object which revealed to Schwabe the secret of the solar period. He had no dream of the discovery before him when he set out upon his researches. His own expression was that he "set out like Saul, looking for his father's asses, and found a kingdom." There are kingdoms yet to be won, even in those fields of astronomy which the telescope cannot touch. In particular, changes which are periodic in character will reveal the fact and circumstances of that periodicity to observations carried on patiently and continuously, even when the amount of such changes at their maximum only just come within the utmost limits of the power of the instruments used in the work.

THE BELT AND SWORD OF ORION.

By ALEXANDER SMITH.

THE photograph of which the accompanying plate is a reproduction—enlarged to about 2 diameters—was taken on February 2 last with an exposure of 2 hours 40 minutes, the lens used being a $5\frac{1}{4}$-in. Voigtländer doublet of 22 inches focus. The camera was attached to the tube of a $12\frac{1}{4}$-in. reflector, which was utilised as a guiding instrument, while the driving power was furnished by a three-pendulum turret clock, whose motion is so regular and certain that very delicate photographic work can be undertaken without risk of failure resulting from any unsteadiness of the driving mechanism.

The development of the plate was prolonged as far as possible with the view of bringing out faint stars, and, although this treatment has obscured all detail in the brighter portion of the Great Nebula, there is little difficulty in tracing on the original negative almost the whole of the fainter outlying wisps of nebulous matter shown on photographs, which have been secured, not only with exposures of longer duration, but with much larger apertures. A comparison of the photographs of this object, which have been published from time to time, shows that the whole region of the nebula exhibits more or less of structure, and the result of a number of experiments I have carried out recently would seem to indicate that satisfactory impressions of such details can only be obtained on a single exposure by departing from the methods of development usually adopted.

Another interesting nebulous region in the constellation of Orion is that surrounding the star Zeta. Following this star is H. V. 28, which is made up of several well-defined patches separated by dark rifts in which there is very little trace of nebulous material. Stretching southwards from Zeta for about a degree is a straight band of nebulous matter, which, although exceedingly difficult to detect visually, can hardly fail to be noted on negatives obtained with fairly long exposures. In the *f.* edge, which is well defined, is a very prominent gap somewhat resembling the "fish-mouth" in the Great Nebula. In the same region there are several nebulous stars. 23 min. south of H. V. 28 is H. IV. 24, and about a similar distance *f.* is another and smaller nebulous star. About 25 min. north of Zeta is a third object of the same class. These can easily be traced on the negative, while a fourth, about 11 min. preceding the last named, is shown on a recent photograph taken by Mr. Henry Ellis with a $20\frac{1}{4}$-in. mirror. Only one of these objects is recorded in the N.G.C., and the region would appear to be worthy of further investigation by those having large apertures at their disposal.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

FAHRENHEIT'S THERMOMETER.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The description which I gave of Fahrenheit's thermometer was merely the result of my enquiries, and was intentionally brief, as I feared to overload your valuable columns. It has called forth the criticism of Mr. Cleveland Abbe, of the Department of Agriculture at Washington, who throws doubt on the statement that Fahrenheit was indebted to Newton for his scale. It is true that neither in Fahrenheit's biography, or indeed in any work of the time, is there any distinct account of the rationale of his scale; for had it been otherwise an explanation of it would have appeared in works of chemistry, the authors of which profess ignorance of its meaning. It is clear, therefore, that what is known can only be gathered by inference from writers who have interested themselves in the matter, and these, as far as my reading has gone, have attributed to Newton the origin of the scale. Mr. Cleveland Abbe gives the figures of these two celebrated men as I have done, and it seems a most remarkable coincidence, should they both have started from the same point between freezing and boiling, and adopted the same number, that they should have done so from perfectly independent considerations. It would be remarkable too, if Fahrenheit had never seen or heard of Newton's instrument, invented a few years before. We have only to multiply Newton's figures by eight, for the reasons already given, to obtain Fahrenheit's scale. The scale of the latter, as your correspondent says, in his first constructed thermometer, was plus 90 and minus 90, but it is not clear how this could have assisted in the framing of his subsequent scale, as the numbers did not refer to freezing or boiling points. That thermometer, as is known, he discarded, and then made another, taking for his fixed point the temperature of the human body. This was Newton's method, by which he had worked. It seems to be correctly said that Newton was in doubt as to a fixed point for boiling, for he speaks of boiling and violent boiling, as if they implied different degrees of heat.

Newton's paper appeared in the *Philosophical Transactions* for 1701, and although anonymous has always been attributed to our great philosopher. It is so said by Brewster, by Kelvin, by Renou and others. Newton begins by saying that he used linseed oil in a glass tube,

XUM

and gives a table showing the height on his instrument at which the different liquids boiled—

"In hujus tabulæ columna prima habentur gradus caloris in proportione arithmetica computum inchoando a calore quo aqua incipit gelu rigescere tanquam ab infimo caloris gradu seu commune termino caloris et frigoris, et ponendo calorem externum corporis humani esse partium duodecim.

"Patet autem per hanc tabulam quod calor aquæ bullientis sit fere triplo major quam calor corporis humani.

"Ex his inventis ponendo calores olei ipsius rarefactioni proportionales et pro calore corporis humani scribendo partes 12 prodiit calor aquæ ubi incipit ebullire partium 33."

(In the first column we have that degree in which water begins to freeze as the lowest degree, making the external heat of the human body to be 12 degrees. Now it is evident from this table that the heat of boiling water is almost three times that of the human body, being 33 degrees.)

In the article on heat in the *Encyclopedia Britannica* by Dr. Mill, late Librarian to the Royal Geographical Society, the writer mentions the paper by Newton, and then describes the thermometer by Fahrenheit, who took his predecessor's scale as his improved standard. After writing this, I had an interview with Dr. Mill, who informed me that from the researches he made at the time of writing his article he certainly came to the conclusion that this was the case, that Fahrenheit copied Newton.

I also enquired of Mr. R. H. Scott, F.R.S., the late Secretary of the Meteorological Council, and he gave me a paper he had written in 1884 in which he says: "We next come to Newton, and in the *Philosophical Transactions* for 1701 we find a paper, certainly from his pen, on the scales of thermometers, and in it he announces that his instrument, filled with linseed oil, is marked 12 at the temperature of man's blood. This is the first notice we possess of a blood heat 'on the scale.' Fahrenheit began by using a scale of minus 90 and plus 90 blood heat. This scale he soon gave up, by Boerhaave's advice, for one with 24 for blood heat. He then divided these degrees into quarters, and this gave him 96 for blood heat. Carrying on his researches he found that water boiled at 212. Such was the origin of the famous Fahrenheit scale."

In the *Philosophical Transactions* for January, 1724, is a short paper, entitled "Experimenta circa gradum caloris liquorum nonnullorum ebullientium instituta; a Daniele Gab. Fahrenheit." The author alludes to the experiment of another chemist, that water boiled at a fixed point (fixo gradu 212°). This he himself confirmed, as well as in most other liquids of which he gives a table. He used mercury as it answered so well in the barometer. I believe most authorities give Fahrenheit credit for first using mercury for a thermometer.

Now I may mention Renou, to whose opinion Mr. Abbe evidently attaches much importance. He says:—

"On trouve dans les *Philosophical Transactions* pour 1701, un article anonyme mais qu'on sait être de Newton. "L'echelle des degres de chaleur."

"Cette article donne les points de fusion et d'ebullition d'un grand nombre de corps, evalués avec un thermomètre à l'huile de lin qui marquant 0° a la temperature de congelation de l'eau, 12° à la chaleur du sang humain, et 34° a la plus violente ebullition de l'eau. C'est le première indication que je trouve dela chaleur du sang de l'homme: on attribue ordinairement à Boerhaave la decouverte de la fixité de cette temperature; je ne sait si ce fait est certain." "Nous avons dit tout a l'heure que Newton avait evidemment pris pour l'un des points fixés de son thermomètre la temperature de sang humain; nous allons voir que, pendant longtemps cette temperature joue un role important." M. Renou then mentioned Fahrenheit's first thermometer, and goes on to say, "Fahrenheit abandonna bientot cette echelle d'apres les conseils de Boerhaave peut-etre et adopta peu de temps avant 1714 une echelle qui ne comportait que 24° comprenant le meme intervalle que son premier thermomètre. Peut-etre Fahrenheit n'avait il pas voulu d'eloigner trop de la division de Newton, mais pour un intervalle plus grand il dut choisir un nombre de divisions double."

[We find in the *Philosophical Transactions* for 1701, an anonymous article known to be Newton's, on the scale of heat. It gave the boiling point in a number of liquids by a linseed oil thermometer, beginning with freezing, making blood heat 12 and boiling water 34. This is the first indication of the heat of the human blood, and this for a long time played an important part. Fahrenheit abandoned his earliest thermometer, and not wishing to depart from Newton's division made blood heat 24.]

SAMUEL WILKS.

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Allow me to refer your two correspondents on the above subject to a paper of my own in the *Journal of the British Astronomical Association*, Vol. XI., p. 339, where they will find Stoddart's alleged observations discussed, and, I think, will conclude that Mr. Maunder does that gentleman no injustice in not accepting his claims as proved.

But I think that in the note in KNOWLEDGE the powers of sight required for different observations are not sufficiently differentiated. The ability to see eleven stars in the Pleiades, and to pick up Vesta and Uranus, or to see Venus at mid-day, is of a different order to the ability to divide ε_1 and ε_2 Lyræ, to define the crescent of Venus, or see the satellites of Jupiter. Of course both abilities may be possessed, as in Mr. Maunder's case, by the same individual, but this is not necessarily so.

I shall be glad to know under what circumstances Jupiter's 2nd satellite can be elongated nearly 4′ of arc. I cannot make it more than 206″ from the limb, and this only in opposition. Although this is about the same distance as ε_1 and ε_2 Lyræ, I think the great difference of magnitude of Jupiter and II. makes the separation a very different matter indeed.

As regards Mr. Rodgers' instance of the visibility of the crescent of Venus, it is defective in the same way as are most of the astronomical feats of this kind, in that neither date, hour, nor place is given, while it is also anonymous. It has convinced *him*, but it cannot be held sufficient to convince others. Besides, most people are aware that the crescent of the moon is convex towards the sun, and would naturally see the crescent of Venus in the same way if the observation was entirely imaginary, and when shown the crescent reversed in the telescope would find it contrary to their anticipations. I believe nine persons out of ten who think they have good sight would see the crescent if one asked them, if reminded it was convex to the sun.

But Venus would be represented by a crescent $\frac{1}{300}$ of an inch long at 10 inches from the eye, or a fourth of an inch at 62 feet. Can any eye make out the shape of such a brilliant crescent? yet Venus would be seen under less steady conditions than such near crescents.

I have only been able to obtain exact date and hour of *one* alleged observation of a satellite of Jupiter with the unaided eye, and on investigation it turns out the planet was about three weeks past quadrature at the time.

The visibility of the crescent of Venus can be experimented upon indoors. Let a crescent 1 in. from cusp to cusp be cut out of card, and illuminated by a lamp placed

behind it. Nine feet away place any polished convex surface, and view the reflected crescent in this at fifteen times the radius of the surface, or the crescent moon will answer the same purpose as the card crescent. The radius of the reflecting convex is not of importance so long as the observer is fifteen times that radius away.

EDWIN HOLMES.

[I thank Mr. Holmes for drawing my attention to the paper to which he refers. I had missed it, as it appeared during my absence in Mauritius. I gave the particulars respecting my own eyesight merely to show that it was not due to any inferiority in it as compared with average sight that I have always failed to define the crescent of Venus. Anyone who has done so must have sight *several times* as good as mine ever was. The maximum elongation of Jupiter II. from the centre of the planet is "almost four minutes of arc" if Jupiter be in opposition and at perihelion at the same time. Thus its elongation was 3′ 54″ on 1880, October 6.—E. WALTER MAUNDER.]

THE USE OF HAND TELESCOPES IN ASTRONOMY.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—May I suggest that the remarks respecting Jupiter and Saturn, on page 81, are somewhat misleading. No note is made as to the visibility of details being affected by the declination of the planets. As long ago as 1861, "Recreative Science" contained (under a *nom de plume*) some observations of mine made with a 1½ in. telescope. With this the crape ring was often seen where it crosses the ball, while Jupiter's belts could not be overlooked. But in 1861 both planets, especially Jupiter, had considerable northern declination. F. W. LEVANDER.

30, North Villas, Camden Square, N.W.

Conducted by W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U.

BIRD MIGRATION.—The *Ibis* for April contains a most valuable contribution to this most fascinating study, by Mr. W. Eagle Clarke, one of our greatest authorities on the subject. Mr. Clarke's observations were made during a month's stay in the famous Eddystone Lighthouse. Deciding that the autumn was the best season for observation, he took up his residence on the 18th September, and left on the 19th of October, 1901. Cloudless and moonlight nights were singularly unproductive, not because no passage-movements took place but because they were beyond the range of observation. The most successful nights were those when the atmosphere was saturated with moisture (rain, haze, cloud). This mixture "becomes more or less opaque, while the powerful beams, streaming out from the lantern upon it, become luminous and brilliant to a very remarkable degree, and exert extraordinary attractive powers over the migrants that pass within their sphere of influence." The main factors in migration movements, Mr. Eagle Clarke points out, are not the winds, but certain systems of atmospheric pressure which establish fine weather-conditions in the North Sea. The winds are the result of these pressure systems, and appealing more to the senses, have come erroneously to be regarded as the principal cause of migratory movements.

MALE BIRDS IN FEMALE PLUMAGE.—The *Field*, April 26th, contains a short but interesting article on this subject by Mr. W. B. Tegetmeier. The author points out that there are breeds of game fowls in which the males habitually wear the female attire, and are known in consequence as "hennies." No less fertility or courage follows the change of livery; on the contrary, "hennies" were remarkable as being the most dangerous birds in the cock-pit. The origin of these hen-feathered birds, Mr. Tegetmeier attributes "to an accidental variation, of the causes of which, like those of other variations, we know absolutely nothing."

ROOKS WITH FEATHERED FACES.—In a letter in the *Field*, May 3rd, it is suggested that Rooks with feathered faces are becoming more common on account of changed habits, the Rook having largely relinquished its habit of digging for food in favour of egg-stealing. This question has been raised and discussed before. So far the evidence seems to lend little support to this theory, but rather to suggest a reversion to the conditions common to all the members of the family save the Rook.

Penguins at the Zoological Gardens.—It may interest our readers to know that an unusually fine collection of these birds can be seen at the Gardens at the present time. The species represented include three King Penguins (*Aptenodytes pennanti*), the Black-footed Penguin (*Sphenisens demersus*), Sclater's Penguin (*Catarrhactes Sclateri*), and the Thick-billed Penguin (*C. pachyrhynchus*).

Bird-Life in Norway.—Land and Water, April 26th, contains an exceedingly interesting article on bird-life in Norway. The bulk of this is a translation of a paper by Prof. R. Collett. Those of us who cannot read Norwegian should be grateful to the translator, for much valuable information has now been made accessible concerning the breeding habits of a number of cliff-haunting species.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. PYCRAFT, *at the Natural History Museum, Cromwell Road, London, S.W.*

BOTANICAL.—An interesting paper on abnormal fruits—a melon in which the seeds had precociously germinated, and an orange, which showed pleiotaxy of the gynaeceum—appeared in the March number of the *Annals of Botany*, contributed by Sir W. T. Thiselton-Dyer. The melon when cut open was found to have its interior filled with well-developed young plants. It was satisfactorily determined that these had not originated from intra-ovarian buds, but from seeds, for in some cases the two halves of the testa were still attached to the cotyledons. The pericarp of the melon, though 1½ inches thick

allowed a fair amount of light to pass through to the seedlings; and the cotyledons were distinctly green, there being, however, a very small development of chlorophyll. Precocious germination sometimes occurs in the orange and other species of *Citrus*, in the papaw (*Carica Papaya*), in Dipterocarpaceæ, and in Rhizophoraceæ. It is known also in Liliaceæ, as illustrated by an exhibition, at the meeting of the Linnean Society on April 3rd, of some seeds of a *Dracaena*, which had developed into small plants while the berries were still hanging on the parent.

Herr H. Molisch records in the *Berichte der deutschen botanischen Gesellschaft*, 1901, p. 32, his observations on variegation in a variety of cabbage (*Brassica oleracea acephala*). This when cultivated in an unheated house during the winter bore distinctly variegated leaves, but in the summer it was noticed in more than a hundred individuals concerned in the experiment that the variegation completely disappeared, to return in the autumn and winter, reaching its highest development about the end of February. This peculiarity was not affected by the nature of the soil in which the plants were cultivated, but appeared to be wholly due to the changes in temperature. Plants removed from a cold house to a warm one in the winter became green, the process beginning in from eight to fourteen days and being completed in about a month. —S. A. S.

ZOOLOGICAL.—For many years those remarkable West African lemurs known as the potto and the awantibo—both characterised by the abortion of the index finger—were the sole known representatives of their respective genera, the second of the two being extremely rare in collections. In 1879, a potto from the Gaboon was, however, described by a French naturalist as distinct, on account of its larger size, longer head, shorter tail, and greyer tone of coloration. Quite recently, Mr. W. E. de Winton, in a paper contributed to the January number of the *Annals and Magazine of Natural History*, has added a species from the French Congo to each group. The new potto (*Perodicticus batesi*) is intermediate in size between the other two species, and of a richer and more rufous colour than either, the tint being almost that of red mahogany. The Congo awantibo (*Arctocebus aureus*) differs from the typical species of Old Calabar by its inferior size, still shorter tail, in which the terminal hairs are stiff and closely pressed together, and the bright golden colour of the fur, which shows no black tips to the hairs. It may be added that the awantibos differ from the pottos by the structure of the hand, the fuller development of the cheek-teeth, the absence of a projecting ridge of the skull above the aperture of the ear, and of projecting processes to the vertebræ of the neck.

An interesting discovery has been made by Miss D. Bate in certain limestone caves in Cyprus. This consists of remains of a hippopotamus of even smaller size than the one from the Maltese bone-fissures, and only about half the dimensions of the common African species. The describer, Dr. Forsyth Major, regards the Cyprian species as the true *Hippopotamus minutus* of Cuvier, and considers that it displays affinities on the one hand with the living pigmy hippopotamus of West Africa, and on the other with an extinct Italian representative of the group. The occurrence in Cyprus of this dwarf fossil hippopotamus is considered to be confirmatory of the view that many of the later Tertiary mammals of the Mediterranean islands were slightly modified survivors of species which disappeared at an earlier date from the adjacent mainland.

Naturalists have long been familiar with a group of extinct crocodiles from the Kimeridge and Oxford clays of which *Geosaurus*, *Dacosaurus* and *Metriorhynchus* are the best known representatives. It has also been long known that these reptiles lacked the bony scutes in the skin of the back characteristic of ordinary crocodiles, and likewise that the fore-limbs were relatively small and weak, and that the eyes were furnished with a ring of bony plates similar to those of the ichthyosaurs, or fish-lizards. From the associated remains, it was also evident that these crocodiles must have been marine. The structure of the lower portion of the limbs has, however, hitherto been unknown. This gap in our knowledge has been bridged over by the recent discovery in the upper Jurassic strata of the Continent of two nearly complete skeletons of members of the group, one belonging to the genus *Dacosaurus*, and the other to *Geosaurus*. These valuable and interesting specimens have been described by Professor E. Fraas in a recent issue of the German *Palæontographica*, where a restoration of the form of the living animal is attempted. From the structure of the skeleton, it is quite evident that the fore-limbs were short and paddle-like, but the hind pair departed less widely from the ordinary type. The jaws were relatively long and armed with powerful teeth; and it is considered probable that the long tail terminated in a strong vertical fin. The creature must apparently have been a formidable rival to the ichthyosaurs and plesiosaurs of the Jurassic seas.

On a previous occasion reference has been made in these columns to the remarkable lower Eocene vertebrate fauna recently discovered in the Fayum district of Egypt, of which a part has been described by Mr. C. W. Andrews. Mr. H. J. L. Beadnell, in a paper published by the Survey Department at Cairo, gives a note, accompanied by figures, of a remarkable horned ungulate skull, for which the name *Arsinotherium* is proposed. At the conclusion the author states that *Arsinotherium*, so far as can be judged by the character of the teeth, is probably "an ancestral form of rhinoceros." From the figure of the teeth (which is far from satisfactory), we take leave to state that this is precisely what the creature cannot have been.

Every step in the evolutionary history of the man-like apes, and therefore of man himself, has more than ordinary interest for the naturalist. It is accordingly a matter of satisfaction to find that the pedigree has been carried one step further back in time by the discovery in the middle Tertiary of Swabia of teeth of a small ape recently described by Professor Max Schlosser under the name of *Anthropodus brancoi*. This ape is regarded as the probable ancestor of the long-known *Dryopithecus* of the French Miocene.

American naturalists continue to describe species and sub-species of rodents literally by the dozen. For instance, in a paper contributed to the *Proceedings* of the Washington Academy, Dr. Hart Merriam names no less than twenty-three mice of the genus *Rhithrodontomys* as new. Whether these are really entitled to rank as new species or races, it is almost, if not quite, impossible for English naturalists to decide, owing to the fact that no skull-measurements are given. In place of this, the skull is said to be longer or shorter, or wider or narrower, than that of the species with which it is compared, as the case may be. If this omission has been made on purpose, it is scarcely playing the game fairly, as it prevents naturalists other than American from determining new species, or revising those already named.

The raking-up of obscure names to replace those long in use for well-known animals seems carried to an un-

warrantable extent by many naturalists of the present day. One of the latest instances is afforded by Dr. J. A. Allen, of New York, who, in the *Bulletin* of the American Museum for February, proposes, on the strength of a passage in Zimmermann's *Zoologicæ Geographicæ* (1777) which may be the result of an error or carelessness, to employ the name *Dama* as the generic title of the American white-tailed deer. By those who regard it as entitled to generic separation from the red deer, the fallow-deer has been invariably designated *Dama vulgaris*, and this usage ought, in our opinion, to bar the use of the former name in any other sense, quite irrespective of whether it was used by some early writer at a date when the binominal system was scarcely established. It is difficult enough in any case to make sportsmen and amateur naturalists realise the essential difference between American and Old World deer, and if a name commonly used for one of the latter be transferred to the former, endless confusion is likely to result. The white-tailed deer is one whose nomenclatural history is singularly unfortunate. The name *Cariacus* by which it was generally known till a few years ago was replaced by *Dorcelaphus* by American writers, who subsequently changed this for *Odocoileus*, and now we have *Dama* suggested.

According to an article in the March number of the *American Naturalist*, a remarkable phenomenon was recently observed on the Californian coast. One day last July a streak of "red water" was noticed some distance off the mouth of San Pedro Harbour, which subsequently broke up into a number of patches, each of several acres in extent. In the course of a few days these patches reached the shore, when the red colour was found to be due to the presence of countless myriads of animalcules belonging to the "flagellate" group. At night the sea was brilliantly phosphorescent over the red area. The most extraordinary fact connected with the visitation was the death of a large number of marine animals, including rays, sharks, and sea-cucumbers, which were apparently poisoned by the animalcules. The bodies of these creatures when cast up on the beach exhaled a most pestiferous odour. At least two hundred miles of coast came under the influence of the "red water."

The Annual Congress of the South Eastern Union of Scientific Societies will be held this year at Canterbury, from the 5th to the 7th of this month. The President-elect, Mr. J. Hutchinson, will deliver the address, and papers will be read by, amongst others, Prof. E. B. Poulton, Prof. G. S. Boulger, Mr. S. Saunders, and Mr. W. Whitaker.

Notices of Books.

"ALCOHOLISM: A STUDY IN HEREDITY." By G. Archdall Reid. Pp. xvi. + 293. (Fisher Unwin.) Price 6s. net.—Mr. Archdall Reid is a philosopher whose works merit careful consideration. He is outside the circle of what might be termed professional evolutionists, but those of us who have given attention to his writings have found evidence in them of an original thinker possessing both knowledge and inspiration. The line of argument in the present book may be expressed as follows. There is an evolution against disease; the native races of West Africa are able to resist malaria because a process of elimination of those susceptible to the disease has been going on for many generations. Englishmen, however, who have not undergone this process of selection are unable to resist the disease. On the other hand, we have acquired a resisting power against consumption, whereas Polynesians and Eskimo perish as surely in London as Englishmen in West Africa. Again, measles is not often fatal with us, but when the disease is introduced into a new race its ravages are terrible. Alcoholism is a disease, and the races which have been liable to it for the longest period are now the most sober. Accepting this, the conclusion is that the reforms advocated by the Temperance party are fundamentally wrong and can only aggravate the evil. "Including the British, all races which alcohol has afflicted have plainly undergone evolution, protective evolution. They began their experience with a great proneness to drunkenness, have ended with a lesser proneness." Nature would in time eliminate those who are predisposed to drunkenness, whereas temperance reformers aim at preserving them. The method proposed by Mr. Reid is to eliminate the excessive drinker by a Malthusian scheme, which, though biologically sound, is altogether impracticable in the present condition of public opinion. This is a mere sketch of the subjects dealt with, and the whole book is well worth attention by general as well as scientific readers. In one or two places we fancy that the investigations of other evolutionists are referred to in disparaging terms, and we regard this as a mistaken policy. Professor Weldon (not Wheldon as is printed on page 38) is contributing to our knowledge of evolution much more than Mr. Reid, though his methods are different. It is unnecessary to refer slightingly to his work or that of any other earnest investigator in the realm of natural knowledge.

"THE FORAMINIFERA: AN INTRODUCTION TO THE STUDY OF THE PROTOZOA." By Frederick Chapman, A.L.S., F.R.M.S. (Longmans, Green & Co.) Price 9s. net.—A well written book by an acknowledged authority is always acceptable, and the present volume is the more welcome because it is an attempt to supply a long-felt want. The classical monographs of Carpenter and Brady are beyond the reach of many students, and the innumerable papers on the Foraminifera which regularly appear in the publications of British and Continental scientific societies are for specialists only. Mr. Chapman has endeavoured, and on the whole, we think, successfully, to compress this scattered knowledge into a single volume of some 350 pages. More than half the work is concerned with the classification of the Foraminifera. The leading characteristics of each family are briefly given, and every genus and sub-genus of any importance is illustrated by a description of one or more types. The author is not always happy in the selection of his types, which, in such a text-book, should, we think, have been selected from the commonest and most widely distributed species available, and whenever possible, from recent forms in preference to fossils. Mr. Chapman, however, shows a marked predilection for fossil types, many of them being of restricted disposition even as fossils. Many of the recent species selected as types are also of rare or extremely local distribution, although other species, common or of world-wide distribution, were equally available for the purpose. The figures illustrating the types are somewhat crude, but sufficient for their purpose. The remaining illustrations are excellent, and to a large extent original, a rare occurrence in text-books. The opening chapters are devoted to the life-history and shell structure of the group, and are excellent, but the space allotted to the life-history is altogether inadequate to the subject. The geological history of the group, on the other hand, is treated at some length, and being well illustrated by sections of the more important foraminiferous rocks is of great interest. Mr. Chapman has himself been one of the most untiring workers at the geological record of the group, and in this chapter he records his opinion that the earliest Foraminifera were derived from forms which did not possess an external shell, but consisted merely of sarcode, perhaps covered by a thin chitinous investment. As such bodies could hardly become fossilized, the theory, credible though it seems, can never be definitely proved. The older theory that the earliest Foraminifera were of the arenaceous type has failed to find any support from the geological record, for in the Lower Cambrian strata the group had already obtained a wide distribution and considerable range of structure, all of the *hyaline* type, while the earliest *arenaceous* forams known at present are of Silurian age. The volume concludes with a good selection of the most important modern works on the subject, the assimilation of which should turn the student into a specialist.

"ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR THE YEAR ENDING JUNE 30, 1900." Pp. lxv., 759. Illustrated. (Washington: Government Printing Office.)—One of the many useful services which the Smithsonian Institution renders to students of science is the publication of the Annual Report

containing the best and most accurate expositions of scientific subjects selected from various sources by the secretary, Dr. S. P. Langley. The papers which appear in the report are reprints from scientific periodicals or the publications of scientific societies, or translations from French, German and other languages. Each report is thus a survey of scientific thought and progress during the year to which it refers. In the report under notice, much space is given to reviews of the progress of science during the nineteenth century, prepared by men distinguished in their various fields. The subjects reviewed are astronomy, chemistry, geology, physics, electricity, geography, biology, medicine and psychical research, which, with an article on the century's great men of science, give in brief a picture of scientific activity of the last century. China, which figured so much in the public eye during 1900 is given special prominence. There is a brief sketch of the Pekin Observatory, the looting of which caused so much comment, and one on Chinese folk-lore. Aeronautics, which during the last decade has been growing to be considered a science, has several articles devoted to it by Dr. Janssen, Lord Rayleigh, Dr. Langley, and others. Among the thirty or more other articles may be mentioned, as illustrating the variety of the subjects treated, papers on malaria and the transmission of yellow fever, by Surgeon-General Sternberg, an essay on Huxley, by Professor Brooks, and a paper on incandescent mantles. The Smithsonian Reports are distributed to institutions throughout the world, and may be had by purchase at cost price from the Superintendent of Documents, Washington City, U.S.A. Their value can only be adequately appreciated by becoming familiar with them, and we recommend all who are able to see them to take an early opportunity of doing so.

"MORE TALES OF THE BIRDS." By W. Warde Fowler. (London: Macmillan & Co. 1902.)—Mr. Warde Fowler has again succeeded in producing a most charming book for juvenile readers, and one which cannot fail to instil a love of the country and a fondness for birds. The author combines the rare qualities of a skilled ornithologist and a story-teller of singular fascination; as a result, the several chapters of his book all faithfully reflect the characteristics of the various birds which he has selected. Only in one case have we come across a jarring note. He goes out of his way, it seems to us, to sow an early prejudice against one of the most ruthlessly persecuted of birds—the heron. Inasmuch as he depicts this poor bird as making a meal of the most sacred person of a trout! It is this occasional piece of audacity on the part of this poor bird that has brought about his undoing wherever trout streams abound, for the proprietors thereof will brook no fishermen but themselves. Thus, the budding naturalist, who may later in life become an enthusiastic angler, is started on his career of persecution of one of our most interesting and fast vanishing birds. Why would not an eel, or a water-rat, have served as well as a trout? They form a far commoner proportion, moreover, of the food of the heron than the fish he selects. The illustrations suggest the hand of a novice, but the pictures of the kite and the sandpipers give promise of very considerable skill in the future, the kite being especially good.

"RESULTS OF RAIN, RIVER, AND EVAPORATION OBSERVATIONS MADE IN NEW SOUTH WALES DURING 1899." By H. C. Russell, B.A., C.M.G., F.R.S., Government Astronomer, New South Wales. (Sydney: William Applegate Gullick.) 1901. Price 3s. 6d. With Maps and Diagrams.—This volume deals with the romance of the raindrops, and although the story is told in statistical form it is full of interest. That the tables of figures which detail the observations made at 1724 stations have been aranged under the supervision of Mr. Russell is a guarantee that they will be found lucid and to indicate clearly the precise nature of the facts dealt with. The publication is mainly concerned with the general results of rainfall observations during 1899, but there are in abundance additional tables that show the rainfall records in Australia at a number of stations during the sixty years 1840 to 1899. These statistics indicate the amount of rain that fell during certain months and years in different parts of the colony, the averages being also given for the purposes of comparison; but in order to complete the full history of the raindrops other particulars are required, and these this volume provides. Thus when once the rain has fallen on the ground it is necessary to learn something of the way in which it disappears. Some of the water, for instance, evaporates almost as soon as it falls; while a certain amount percolates underground. Much of the water, again, may rush over the surface of the ground into the rivulets, streams, and rivers and so produce floods. To engineers and others, therefore, who are concerned with reservoirs, springs, and wells, not only is it important to be told the depth of rain that fell, but on the other side of the account something should be said concerning evaporation, percolation, and floods. As regards the latter, Mr. Russell gives the height of certain rivers from day to day, the figures being obtained by means of river-gauges and flood-marks placed on bridges. There are no percolation observations in this book, but since there are so many other interesting tables and diagrams no one would find fault with the omission, although a few such details would have added to the value of the volume. The statistical part of the observations is illuminated by seven diagrams at the end of the book, and reference may be made to one of them which shows the monthly distribution of the rainfall in different districts, and reveals the character of the year's rainfall in a most excellent manner. Another diagram has reference to the debatable question of the moon and the weather, Mr. Russell is "convinced that there is some connection between the two." Meteorologists as a body are, however, not yet persuaded that any hints as to future weather are to be gained by looking in this direction, and those who are engaged in preparing what may be termed the official forecasts prefer, at present, to consult a synchronous chart rather than the moon. In order that the mean annual rainfall over New South Wales as a whole, which is 25 inches, may be compared with other parts of the world, Mr. Russell has compiled a table giving the averages for thirty-three representative localities. At the head of this table stand the Khasia Hills, India, with a mean annual rainfall of 600 inches, Madrid with 9 inches is at the bottom; London has 24 inches, and New York 47 inches. But no attempt must be made here to extract the statistical "plums" from this well-compiled volume, to which anyone interested in rainfall matters may safely be commended.

"THE NEARER EAST." By D. G. Hogarth, M.A. With Maps and Diagrams. Pp. xv., 296. (Heinemann.)—This volume is the second of the series edited by Mr. H. J. Mackinder, having for its object the description of the great regions of the world in relation to the people inhabiting them. Geography as it is now understood is concerned with the influence of environment upon human life; it is an endeavour to determine the conditions which have led to the adjustment of things as they are. The most important factor is the relief of the earth's surface, which determines to a large extent the climatic conditions, and through this the character of a race, causing, for instance, the peasant of the Nile Delta and the fellah of the Upper River to be very different beings. The density of the population is largely dependent upon the nature of the country. Thus, while Egypt with desert areas included has a population averaging about 12 to the square mile, the number on the land without deserts amounts to 600 per square mile. By several remarkable examples, Mr. Hogarth shows how the character of man is affected by the nature of the available food supply. "Over the immense area of south-western Asia, where grain can be cultivated so little as to be in no sense a staple food, and the date fruit, heating and satisfying, but not of equal nutrition, takes its place, we find one character of man, restless and alert, but incapable of sustained action or any but the most superficial and conventional thought." There is, in fact, a regular gradation in an upward scale of physical endurance and intelligence from the lowest date-eating Bedawin to inhabitants of the Lebanon and the Syrian coast, where wheat and olive, milk and wine, are among the staples of life. We cannot refer to the many other interesting facts of a similar nature described by Mr. Hogarth. About one-half of his volume deals with the physical geography of the "Nearer East," which includes the tracts of lands which lie in and about the eastern basin of the Mediterranean Sea. The second half is concerned with the distribution, character and conditions of human life in this region. The book shows how geography can be studied in a perfectly scientific manner, and will thus do something to remove the re-impression that the subject has no place among the sciences. The author has overlooked the loose expression "different to" on page 17.

"A CONCISE DICTIONARY OF EGYPTIAN ARCHÆOLOGY." By M. Brodrick and A. Anderson Morton. Pp. viii. and 198. (Methuen.) Illustrated. 3s. 6d.—Students and travellers may find this little handbook of service, but they must of course

recognise that it only contains a limited statement of the position of Egyptology. A few points worth remark occur to us in glancing through the pages of the book. A list of the principal gods might have been given; at present the word "god" is not indexed. We also miss the words "metals" and "chronology," though both deserve a paragraph. Under "zodiac" it is stated that the zodiacs found in Egypt "were borrowed from the Greeks," whereas the reverse was probably the case. Under "temples" no mention is made of the care taken in their foundation to keep the axis in a definite direction, or of their use for observations of the rising or setting of the sun and stars; and no reference is made to the remarkable fact that the bases of the Great Pyramids lie in the four cardinal points. Sirius is said to be in the constellation Canis, instead of Canis Major. Concerning the source of the Nile it is remarked "modern travellers place it in the Victoria Nyanza Lake, but it is quite possible that it rises even further south of the Equator." Whether the Kagera, the Shimeya, or the Mwaru is the head stream of the Nile may be doubtful, but no one now considers the Victoria Nyanza to be the source. Putting aside minor mistakes of this character, the book will be handy as a guide, though it cannot be taken as authoritative.

"AN INTRODUCTION TO THE STUDY OF THE COMPARATIVE ANATOMY OF ANIMALS." Vol. II. By Gilbert C. Bourne, M.A., D.SC., F.L.S. (London: George Bell & Sons. 1902.)—As in his previous volume, Dr. Bourne has contrived to crowd into a small space a vast amount of information specially designed for students reading for the preliminary and intermediate science examinations in the Universities of Great Britain. But so well has the work been planned, and so carefully and discreetly have his facts been selected that we venture to predict his two volumes will be treasured long after they have served the purposes for which they are written. The present volume deals with the platyhelmia, annelida, mollusca, gastropoda, arthropoda, cephalochorda, elasmobranch fishes and mammalia, and contains a chapter on the development of the frog. According to the plan of the work only the essential features of the various groups are discussed, and room is even found, here and there, for philosophical speculation which must certainly greatly add to the value of the work.

We have received several volumes of the Unit Library. The main feature of this latest addition to the growing family of miniature booklets is that they are to be sold at prices based on the number of pages, irrespective of internal worth. The covers and general appearance are pleasantly decorative and the type clear.

BOOKS RECEIVED.

The Criterion of Scientific Truth. By George Shann. (Cassell.)

Arithmetic and Algebra. By John Davidson, M.A. Edited by John Adams, M.A., B.SC. (Hodder & Stoughton.) 2s. 6d.

Dynamic Aspects of Nutrition and Heredity. By Frank Horridge. (Baillière, Tindall & Cox.) 5s. net.

The Conflict of Truth. By F. Hugh Capron. (Hodder and Stoughton.) 10s. 6d.

Other Worlds. By Garrett P. Serviss. (Hirschfeld.) 6s. net.

Complete Works of Miguel de Cervantes Saavedra. Vol. VIII. (Gowans & Gray.) 1s. net.

Elementary Plant Physiology. By D. T. MacDougal. (Longmans.) 3s.

Remarkable Comets. By W. T. Lynn. (Sampson Low.) 6d.

Mosaic Account of Creation Verified by Science. By George Dickison. (Stock.)

Results of Meteorological and Magnetical Observations. (Stonyhurst College Observatory.)

Religions of Bible Lands. By D. S. Margoliouth, M.A. (Hodder & Stoughton.) 1s. net.

Will Power. By Richard J. Ebbard. (Modern Medical Pub. Co.)

Nature Note Book. By W. L. Boys-Smith. (Allman & Son.)

The New Phytologist. Vol. I., No. 4. 1s. 6d.

The Lens. By Thos. Bolas, F.C.S., F.I.C., and George E. Brown, F.I.C. (Dawbarn & Ward.) 2s. 6d. net.

Edward Edwards. By Thomas Greenwood. (Scott, Greenwood & Co.) 2s. 6d. net.

Journal of the Anthropological Institute. Vol. 31, 1901. 10s. net.

Regeneration. By Thomas Hunt Morgan, PH.D. (Macmillan.) Illustrated. 12s. 6d. net.

Occultations of Stars and Solar Eclipses. By Francis Cranmer Penrose, M.A., F.R.S., &c. (Macmillan.) Illustrated. 12s. net.

Experiments with Ionized Air. By Carl Barus. (Smithsonian Institution.)

Report of S. P. Langley, Secretary of the Smithsonian Institution for the Year ending June 30th, 1901.

Conférence Astrophotographique Internationale, July, 1900. (Paris: Gauthier-Villars.)

Manual of Tides. Part IV.A. Outlines of Tidal Theory. By Rollin A. Harris. (Washington: Government Printing Office.)

Magnetism in Growth. By Silvanus P. Thompson, B.A., D.SC., F.R.S. (Frowde.) 1s. net.

Small Dynamos and Motors. By F. E. Powell. (Dawbarn & Ward.) 6d. net.

Lord Kelvin, G.C.V.O. By John Munro. (Bijou Biographies, No IX.) (Drane.) 1s.

Notes on the Construction of the Violin. By W. B. Coventry, M.INST.C.E. (Dulau.) 2s. 6d. net.

Story of Animal Life. By B. Lindsay. (Newnes.) Illustrated. 1s.

Summer Birds of Flathead Lake. By P. M. Silloway. (University of Montana.) Illustrated.

Journal and Transactions of the Leeds Astronomical Society (1901). (Wesley & Son.) 2s.

Hints to Meteorological Observers. By W. Marriott, F.R.MET.SOC. Fifth Edition. (Royal Meteorological Society.) Illustrated. 1s. 6d.

Rhodes' Steamship Guide. Edited by Thomas Rhodes. (Philip.) 2s.

Essays Civil and Moral. By Francis Bacon. (Ward, Lock.) 2s.

Essays in Historical Chemistry. By T. E. Thorpe, C.B., LL.D., F.R.S. (Macmillan.) 12s. net.

Principles of Inorganic Chemistry. By Wilhelm Ostwald. (Macmillan.) 18s. net.

Country Gentlemen's Estate Book, 1902. Coronation Edition. (Country Gentlemen's Association, Limited.) Illustrated. 3s. 6d. net.

Butterflies and Moths of Europe. By W. F. Kirby, F.L.S., F.E.S. (Cassell.) 7d. net.

Photographic Catalogue. Jas. Woolley, Sons & Co., Limited.

THE NOBODIES,—A SEA-FARING FAMILY.

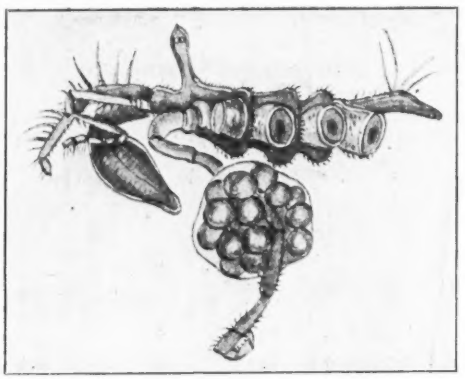
By Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S.

CHAPTER III.

IN the upper classes of the animal kingdom, among creatures that display bilateral symmetry, the head is always set on in front. When Herodotus heard from the Libyans of a headless tribe with eyes in their breasts, he characterized this and some other marvels as a pack of lies. A sermon attributed to St. Augustine makes the eloquent Numidian bishop claim to have actually seen the tribe of which Herodotus had only incredulously heard, but the sermon has been denounced as a shameless forgery. Stories there are of men who carry their heads under their arms. Anyone can do that who appropriates his neighbour's head for the purpose. Such an exception is purely artificial. Even the Pycnogonida have their heads in the ordinary position, though for reasons best known to themselves here again they are not content to do the usual thing in the usual fashion. A dispassionate observer, unbiased by inquisitive researches, would readily, one might almost say reasonably, conclude that for this group the head is constituted by the prominent, generally large, often very freely movable, front portion of the animal which contains the mouth. Head and mouth are in fact among the names which have been applied to this part. It has also been designated by words signifying rostrum, siphon, proboscis. Of the five, the last has been the favourite term. It must not, however, be taken to imply a nasal prolongation, as in the elephant and the tapir; nor is it composed of modified jaws as in insects. This was an early view of it, which recent authorities strenuously reject It is tubular, with a cylindrical or fusiform appearance emerging from a three-sided structure, in which an upper plate forms the roof, the other two constituents meeting in a more or less keel-like manner below. The opening and shutting of the mouth at the anterior end is managed by three little valve-like plates, or some equivalent arrangement. The internal mechanism is described by E. B. Wilson as an apparatus for masticating food, by Meinert as a filtering apparatus, by Dohrn as a creel-like trap contrived, like those in which crabs and lobsters are caught, to let things in and not to let them out again.

It is generally agreed that, in animals which take food,

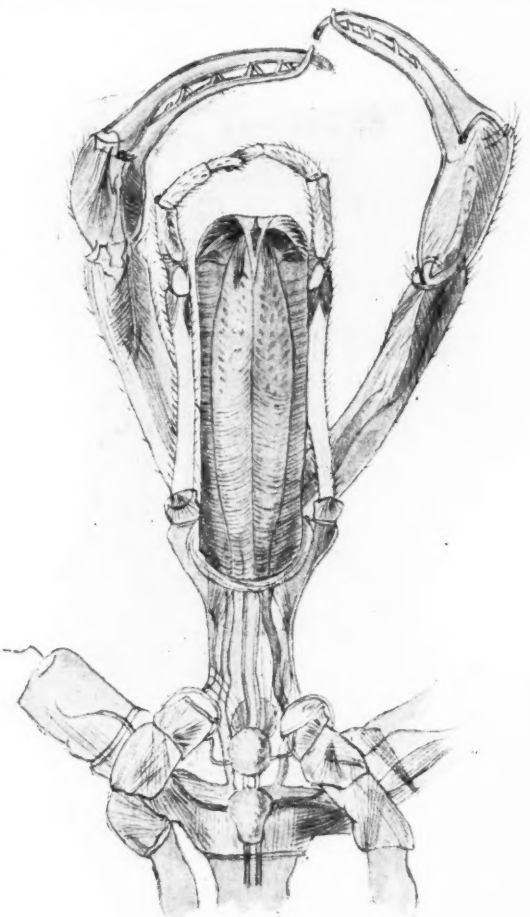
whatever else may be or not be the appurtenances of a head, it always includes the mouth. A head without a mouth is worse off than a duke without a duchy. So far then the proboscis above described by having a mouth makes a capital claim to be the head, and when it happens to be fusiform, its neck-like attachment to the rest of the body gives it a semblance of being not merely a part of the head but the whole. Many animals, crustaceans and spiders for example, dispense with a neck, having the head fused with the trunk. But it is not easy to think of an animal which has a neck in the middle of its head, enabling it to double one half under the other. This singular acrobatic performance is, however, accomplished in the



Eurycyde hispida (Kröyer); ambulatory legs omitted. From Sars.

present group, as for instance by *Eurycyde hispida* (Kröyer); but it needs some explanation. For arthropods in general, and for vertebrates it must be admitted that, besides the feeding aperture, two other constituents of supreme importance, the eye and the brain, are always localized in the head. The eyes and brain do not wander away from the head of an arthropod, unless they wander away from the animal altogether. Yet look now at these perverse Pycnogonida. Behind the proboscis, which is sometimes relatively huge, there is a body consisting of four segments, followed by a little trivial abdomen, articulated or in coalescence, depressed, outstanding, or more frequently upturned. The four segments of the trunk are often very distinctly separated one from the other, but in some species they are more or less fused together, although the original independence of the last three is always sufficiently guaranteed by the pair of legs which each has in attachment to its sides. The first segment also has a similar pair of legs in similar lateral attachment, but it has much more. It is capable of bearing three other pairs of appendages, and sometimes, though not always, exercises this capacity. The nervous mass that does duty for a brain is lodged within it. On its outside rises an eminence, a little watch-tower, normally beset with four simple eyes, two of which look backward and two forward. That this first segment, then, to judge by the four pairs of appendages, is in reality composite, few zoologists will be inclined to dispute. That part of it is cephalic or in the nature of a head-piece, since eyes and brain are lodged in it, most will readily admit. But this admission carries with it the inference that the proboscis, notwithstanding its possession of the buccal orifice, is not properly or exclusively the head. It may rather be regarded as the throat and mouth projected strongly forward so as to assume an abnormal prominence. It is in keeping with the eccentric character of these creatures, the "nobodies" of our title, that they should thus threaten immense gulosity in spite of those circumstances which convict them of hermit-like abstemiousness.

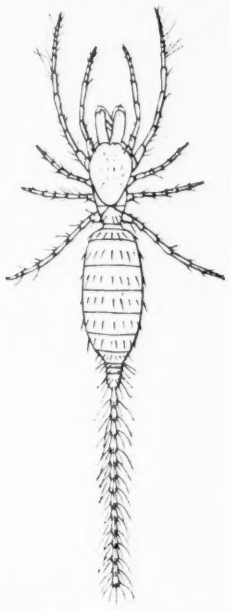
The three pairs of appendages that precede the walking legs on the composite first segment appeal for distinctive names, and still remain in the distressful condition of not knowing with any sort of certainty what to call themselves. Of the first pair it may be said that they are normally three-jointed and chelate. They frequently extend beyond the proboscis in a way that would seem convenient for offering meat to its mouth. But they display many vagaries. Very occasionally they are four-jointed, sometimes they are two-jointed or one-jointed, or no-jointed, disappearing altogether. Under some of these conditions they cease to be chelate, not being able to form pincers with fewer joints than two, or not choosing to do it with that number or more. At times they remain chelate,



Nymphon perlucidum, Hoek. Front of body from below. From Hoek.

though not reaching so far as the mouth-opening. It must be tantalizing to the mouth if they persist in offering food from an unattainable distance. But perhaps they adopt the policy of the long spoon, presenting a desirable morsel on the end of a stalk. In contrast with the inconstancy and variability of these appendages in the adult, they are found to be in the larva, so far as is known,

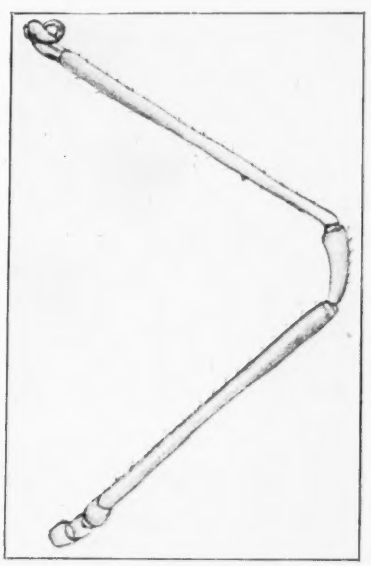
always present, always three-jointed, always chelate. By that fact may be justified the convenient designation "chelifori," which has been applied to them, since in all species they are at least for some part of the animal's life carriers of chelæ. Still such a title is merely neutral. It is secure from criticism because it leaves out of sight considerations of homology. It is unhelpful to those who would fain know the relation of these chelifori to corresponding appendages in other arthropods. In this respect there is an embarrassing choice of opinion, for some think them equivalent to the first pair of antennæ and some to the second, some to the mandibles, and some to a pair of maxillipeds. It is, perhaps, worth while going a little out of our way to illustrate the perplexing obscurity of the problem. A remarkable arachnid, *Kœnenia mirabilis*, first described by the Italian authors Grassi and Calandruccio, was afterwards more exactly studied by the Danish savants H. J. Hansen and W. Sörensen. Recently Dr. Meinert, while



Kœnenia mirabilis, G. and C. After Hansen.

referring with high praise to the description and figures supplied by his colleagues at Copenhagen, deduces from them a conclusion which they themselves do not accept. He finds in *Kœnenia* a proboscis homologous with that of the Pycnogonida. Projecting in front of its mouth are seen a pair of "antennæ," three-jointed, chelate, which not a little resemble the pycnogonid first appendages. There is a further point of comparison. In the scorpions, pseudoscorpions, and many of the Pedipalpi, the "cheliceræ" are followed by long chelate organs forming the second pair of appendages. In the Pycnogonida the second pair, though as variable as the first, are never chelate, and in this respect they again agree with *Kœnenia* as well as with some of the Pedipalpi. But *Kœnenia*, it will be seen, has only six pairs of appendages, not the mystic pycnogonid seven. Among all the peculiarities of the latter group it would surely not be the least, if *Kœnenia* with the abdomen abnormally developed could be proved to be the nearest living relative of a tribe which has the abdomen abnormally insignificant. Such a conclusion is at present highly improbable.

The second appendages, or "palps" as they have been most commonly called, have a number of joints varying from ten to five, and are liable to vanish entirely. When present they have their place of attachment generally close to the chelifori, and a neck-like constriction of the supporting segment often puts them far apart from the ovigerous legs. Yet, when the segment is very short, they are sometimes brought into close contiguity with these, which in their turn lie close to, or rarely at a little distance apart from, the first pair of walking-legs. The ovigerous function has been already discussed. The third appendages to which it belongs have other claims to attention. In the first place, however convenient they may be to their possessors, they are very trying to the systematist. They helped Savigny to a comparison of the Pycnogonida with a crustacean type, but it was fanciful and untenable. When the comparison is transferred to all existing Arachnida, *Kœnenia mirabilis* included, this third pair of appendages appears to be a pair too many. Semper overcomes this difficulty by regarding them as a new formation, and Meinert thinks this a fair solution, in opposition to Dohrn, who regards it as an explanation which merely confesses inability to explain. In regard to the Entomostraca a theory was long maintained by the late distinguished professor, Carl Claus, that the two branches of a crustacean limb could separate and form two apparently distinct appendages. He sometimes complained that this discovery was ignored or not sufficiently appreciated by the scientific world. One sees how exceedingly convenient it would be in the present difficulty if one might suppose that the second appendages in the Pycnogonida were mere offsets either of the first pair or the third. There are obstacles in the way of this solution. The bifid structure, so common in crustacean appendages, has

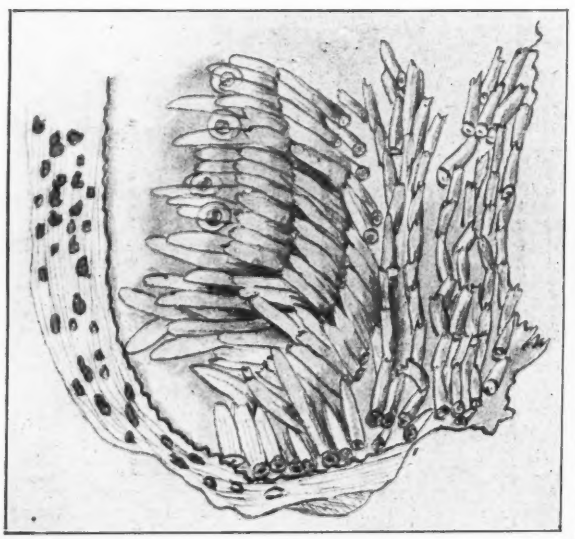


Ovigerous leg of *Colossendeis gigas*, Hoek. Natural size. From Hoek.

no prominence in those of the Arachnida or Pycnogonida. But the position of affairs would not be much improved if it had, for it so happened that, just as the world was coming to accept the late professor's theory, solid objections were raised to it by other naturalists and eventually it was abandoned by its author. The origin, then, of this third

pair of appendages remains mysterious. The minutiæ of their structure, without making much appeal to the unaided eye, show some striking and beautiful characters under the microscope. The weak-looking joints at the end of the limb are usually bordered with rows of spines, of which the varied sculpture would scarcely be suspected until it has been seen under a high magnification. The numbers and shapes of these leaf-like and sometimes strongly denticulate spines are helpful in generic distinction. The number of them may be quite trivial or it may amount as in *Colossendeis gigas*, Hoek, to several hundreds. The worn condition of the apparatus in the specimen figured implies a period of active service, and considering that the species in question is capable of growing legs twelve inches long, it may well be that the cleansing appendages find themselves severely taxed in brushing up and keeping trim all the four pairs.

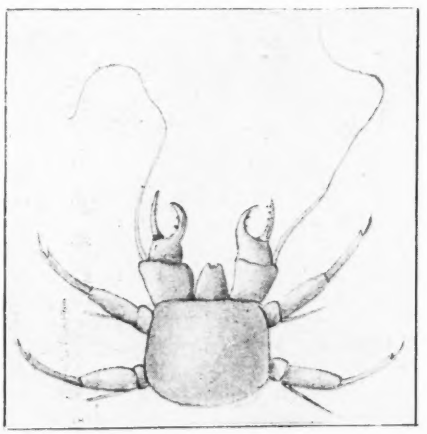
Unlike the organs already discussed, the ambulatory limbs, with only one known exception, have always the same number of joints, which is nine. *Gnamptorhynchus ramipes*, Böhm, is without the terminal joint in the first pair. Of the nine joints, the middle three are almost invariably the longest. In other respects there is abundance of variation, distinguishing legs that are stumpy from legs that are of a marvellous attenuation, legs that are spiny from legs that are smooth, and especially legs that have the ninth joint or claw accompanied by a couple of auxiliary claws from legs that have no such accessories. Dr. Meinert says, "These auxiliary claws are really the terminal claws of the foot, originating from and attached to the last joint (the claw) of the foot. In so far they are real



Spines on ninth joint of ovigerous leg; *Colossendeis gigas*, Hoek. Highly magnified. From Hoek.

claws, and correspond to the claws in the Arachnida and most Insects. Corresponding claws are wanting in the Crustacea, and therefore their presence in the Pycnogonida is of no small systematic importance; it is to be remarked, however, that they often become rudimentary or quite disappear, but, nevertheless, they may be said to be typical in this group of animals." As qualifying this view it should be borne in mind that supplementary claws are not unknown among Crustacea, at least as occurring on the inner side of the principal unguis, while on its outer side the Amphipoda quite usually have a seta at the very point at which in pycnogonids the auxiliary spines originate. But between setae and spines nature has left no interval unbridged.

To complete the account of the appendages, the patient reader must allow his thoughts to be transferred to the time when the young pycnogonid is just escaping from the egg and still trusting to the benevolent support of its father's arms. Between the emerging larva, more compact than graceful, and the parent, usually with long, slim, radiating limbs, there is almost no resemblance. In the earliest stage, which may exceptionally be passed within the egg-cover, the little creature has no abdomen, but a swollen trunk and three pairs of appendages, this latter characteristic suggesting a comparison with the crustacean nauplius. But here the first pair are chelate, and the



Larva of *Pycnogonum littorale*, Brünnich. After Kröyer.

two following pairs are simple, not two-branched as in the nauplius, so that the difference is very substantial. With the progress of development the four pairs of walking-legs successively appear. But in the meantime, according to Meinert, the second and third larval appendages are thrown off, and then the "palps" and "ovigerous legs" come on to the scene, Meinert's theory being that these are not representatives of the two discarded larval pairs, but of quite independent origin. Hence he affirms that the typical number of pairs of limbs in the Pycnogonida is not seven but nine. Of these nine, he holds that the last four pairs "are not at all homologous with the ambulatory legs of the Arachnida, but in all likelihood with the four pairs of small processes that have been pointed out in the abdomen of the Arachnid-embryo." Taken altogether, the arguments he uses to justify his classing this group among the Arachnida may rather incline observers to leave him in this respect ploughing a lonely furrow. In 1891, Prof. G. O. Sars expressed the belief "that all naturalists are at present unanimous that those animals [the Pycnogonida] can neither be referred to the Crustaceans nor the Arachnidans, but must form a class by themselves."

Future researches may at any time remove the group from its splendid isolation. For the present, in regard to external relationships, we shall do well to leave it alone in its glory. Within its own confines there remains to be considered the relative importance of agreements and differences on which the distinctions of its species, genera, and families have been founded.

Conducted by M. I. CROSS.

POND-LIFE COLLECTING IN JUNE.—The months of April and May have been so abnormally cold this year that it is to be expected many of the pond organisms which usually make their appearance in May will have been retarded, and will only come on in June. There are, however, summer forms which hardly ever occur earlier than June, and the most interesting of these amongst Rotifers is *Pedalion mirum*, with its six arthropodous limbs; *Synchæta stylata*, with its long-spined floating eggs, and *Synchæta grandis*, the largest species of this genus, may also now be looked for in lakes and water reservoirs, as well as the rare free-swimming *Floscularia pelagica*. In the same waters will be found two free-swimming colonies of Vorticella: *Epistylis rotans* and *Zoothamnium limneticum*. In June it often happens that certain water-fleas, Daphnia and Bosmina, also Cyclops and their larvæ, increase to such an extent as to render the existence of free-swimming Rotifers almost impossible in these waters, and the latter consequently quickly disappear, though they may have been swarming a few weeks earlier. In ponds, however, where this does not occur, Rotifers of many genera may be found, and attached to submerged water plants *Lacinularia socialis* and *Megalotrocha albo-flavicans* should be looked for, whilst in reedy ponds the free-swimming spheres of *Conochilus volvox* may occur. Mossy pools, in addition to their special rotiferous fauna of *Philodinæ*, *Callidinæ*, *Adineta*, *Cathypnæ*, *Distyla*, and *Monostyla*, will also contain waterbears and shelled Rhizopods such as *Diflugia* and *Arcella* and numerous free-swimming Infusoria. Polyzoa, such as *Plumatella repens*, *Fredericella sultana*, *Lophopus crystallinus*, and *Cristatella mucedo*, though not common, should be abundant in suitable localities.

COVER-GLASS CORRECTION.—With dry microscope objectives of considerable numerical aperture, the thickness of the cover-glass through which an object is examined is found to seriously affect the definition of the image: an objective which is quite satisfactory with some definite thickness of cover-glass showing decided spherical aberration in the sense of under-correction when the cover-glass is thinner, in the sense of over-correction when the cover-glass is thicker, than the standard adopted by the optician. This spherical aberration results from the refraction of the rays in the plane surfaces of cover-glass and objective-front respectively, and is negative for the cover-glass surface, positive in the front lens-plano, the latter preponderating owing to the greater diameter of the cone of rays from the object where it enters the front lens.

With the right thickness of cover-glass, the remaining under-correction is exactly balanced by an equal over-correction in the lenses of the objective; but a *thin* cover-glass produces insufficient over-correction (the diameter of the cone of rays being too small where it meets the surface of the cover-glass); a thick one too much.

As it is not practicable to strictly adhere to the standard thickness of cover-glass adopted by the makers of an objective, it becomes necessary, at least in critical work, to compensate for the effect of the cover-glass, and this can generally be done in two ways, viz.:—

1. The tube length is found to affect the spherical correction, lengthening of the tube introducing over-correction, shortening of the tube under-correction. Hence, we may generally secure good definition with objectives in fixed mounts, even when the thickness of the cover-glass differs considerably from the standard, by adjusting the tube length, thick covers requiring a shorter, thin ones a longer, tube. It may, however, be mentioned that some of the relatively cheap "achromatic" or "semi-apochromatic" objectives by leading Continental makers form a curious exception; they give very good definition with their standard cover-glass, but no alteration of tube length seems to enable one to get anything like the same definition with cover-glasses of considerably different thickness.

2. With objectives of short focus the range of tube length is hardly sufficient for the purpose of compensation; for these the adjustable mount—"correction-collar"—is a very desirable and useful arrangement, which acts by altering the distance between the front and back lenses of an objective. A reduction of this distance introduces under-correction; an increase, over-correction, and a scale on the "collar" serves to indicate the position of the lenses.

Most English opticians seem to adhere to the old plan—very convenient and inexpensive to them, but puzzling to the microscopist—of an arbitrary scale; the German plan of carefully marking the scale so as to show the thickness of the cover-glass in 1/100ths of a millimetre seems ever so much more convenient and useful.

With an objective having a scale thus divided and an object under a cover-glass of known thickness, the use of the collar is simplicity itself; we simply set the collar to the division of the scale corresponding to the thickness of the cover-glass, and the tube length to that stated by the maker, and the instrument will at once give its best definition.

But generally these ideal conditions do not exist, and then the adjustment of the tube length, or of the correction-collar, becomes a delicate and difficult operation, which may, however, be accomplished in a systematic manner, if we bear in mind that we are aiming at the elimination of "spherical aberration." The latter may be defined as a difference of focus between the central and marginal zones of an objective. Hence the correct tube length or the correct position of the correction-collar has been found when some strongly-marked detail or outline of the object remains in exact focus under any change of illumination, say from a small to a large diaphragm opening, or, better still, from central to very oblique light, these changes being of course made very carefully so as not to disturb the other adjustments.

The following *modus operandi* will be the safest and quickest. Start with the shortest tube length, or when there is a correction-collar with the position corresponding to the thickest cover-glass, carefully focus some sharp outline with, say, a ¼ central cone; then change to a ¾ cone, or, still better, to very oblique light. Unless the object—owing to an exceptionally thick cover-glass or a very badly-adjusted lens—is beyond the range of your adjustments, you will find evidence of under-correction, that is, the lens will have to be brought closer to the object with the wide cone, or oblique light, than with central light.

Gradually lengthen the tube, or turn the collar, repeating the above observation after each changing until all evidence of spherical aberration has disappeared; the instrument is then in correct adjustment *within your own limits of vision*.

It is advisable to start with the adjustment corresponding to the thickest cover for the simple reason that this lessens the danger of running through the cover-glass and destroying the object and possibly the front lens of the objective when dealing with a lens of a short working distance.

PRACTICAL SCHEME.—A reader—Mr. J. Searle, of Oporto—has kindly sent a considerable number of centipedes of an unusual kind, which I have so far been unable to get identified, for distribution among readers of KNOWLEDGE. Unfortunately they have been sent in a dry condition, and very few of them are, in consequence, whole, but, with care, very interesting slides can be prepared of the various parts, and especially the legs, which appear to be the most interesting feature.

I am hoping, within the next few weeks, to receive a further quantity from this gentleman, preserved in spirits of wine, and shall be pleased to send a specimen to a limited number of readers who apply for same, enclosing a stamped addressed envelope.

The method of treatment for these insects would be as follows:—Place them in water for three hours, transfer to ten per cent. of caustic-potash in distilled water until they become soft; this will probably take some days. When soft, pour away the potash and add water, which must be changed several times until all the potash is washed away. Pour away the water and add concentrated acetic acid and soak for twelve hours, or until a convenient time for continuing the process, when they should be transferred from acetic acid to water and soaked for half an hour. Lay out in the manner desired, and after once more

XUM

hardening in spirits of wine, and clearing in clove oil, they should be placed in turpentine and mounted in Canada balsam.

Full particulars of the above processes will be found in the many works that give instructions in mounting.

ADVICE IN PREPARING SPECIMENS.—At this time of year many microscopists will be collecting specimens which will prove interesting under the microscope, and would, no doubt, in many cases, wish to permanently preserve them. I shall be pleased at all times to give any advice or assistance I can to aid in such work.

NOTES AND QUERIES.

R. W. S.—Desmids should grow well in a shallow cell in some of the water in which they were found; tap water will not do. I am unaware of the existence of the article in the journal you mention.

T. H. A.—The specimen you send is not sufficiently perfectly mounted for identification, but it looks uncommonly like the Spinning Mite of the lime tree, *Tetranychus telarius*.

Ignoramus.—Good portable microscopes, as well as instruments suitable for the purpose of an amateur, are supplied by all the makers whose advertisements appear in these columns. For examining flowers, etc., Mr. C. Baker, of 244, High Holborn, makes an especially convenient little instrument called the "Plantation" microscope, which would probably do all you require. Good second-hand microscopes can be obtained from several houses, and particularly Messrs. Clarkson & Co., of Bartlett's Buildings, E.C. The book that you would probably find most serviceable is "A Popular Handbook to the Microscope," by Lewis Wright, price 2s. 6d.

C. M.—I have referred your letter to the gentleman who has kindly consented to act as consultant with regard to Rotifera, and he replies as follows:—"I am afraid that the smaller Entomostraca are, like the poor, always with us. When collecting myself, I pass all the water through a small strainer (sold in the streets for a penny), and I find that this keeps out all the larger forms such as Daphnia, etc. I must admit I do not find many free-swimming Rotifers as large as Daphnia or Cyclops, unless the latter are very small, but I think your correspondent would find it possible to make a muslin strainer coarse enough to let through most of the Rotifers, and at the same time keep out all the large Entomostraca. But to get rid of Cypris and Chedorus I am afraid will require a pipette and infinite patience."

Correspondence is invited on the subject matters dealt with in these columns. Readers may see subjects from different points of view and their criticism will be welcomed.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn*, *W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NEW COMET (1902 A).—A new comet was discovered by Mr. W. R. Brooks, of Geneva, U.S.A., on the morning of April 15th, when it was in about 344° + 29°, and two degrees north of β Pegasi. The comet was travelling rather quickly to the south-east, and it was observed on April 17th by Prof. E. Hartwig, at Bamberg, who described it as of $8\frac{1}{2}$ magnitude, about three minutes of arc in diameter, and with a tail neary half a degree long. The object approached the sun so rapidly that it was only observed for a short period, and it arrived at perihelion on May 7th, when in a position about 25 degrees south of that luminary. Thereafter the motion was directed towards north-east, but it soon slackened and prevented the comet from emerging from the sun's rays to become visible in the evening sky. The object receded rapidly from the earth, and its apparent brightness declined to such a degree that it is questionable whether it was seen at all after its perihelion passage, except from stations in considerable south latitude. The comet's apparition may be regarded as a very fugitive one, and the conditions appear somewhat similar to those which affected the great southern comet of last spring, and confined its visibility to narrow limits.

GREAT DETONATING FIREBALL SEEN IN SUNSHINE.—On the morning of April 10th, at about 10h. 55m. G.M.T., when the sun was shining brightly, a large fireball was seen in the northern sky from Dunsink, Co. Dublin, and Carlow, and at about the same time a strange sound was heard over East Tyrone by many people, who were startled at its unusual character, and considered it either the presage or accompaniment of an earthquake. A large number of descriptions of the phenomenon have been published in the *Irish Times*, and a few accounts have been privately communicated. From these the following are selected:—

Mrs. Martin, of Dunsink, says:—"While walking down the fields my atenttion was attracted by a rushing noise above my head, and glancing up I saw a beautiful pear-shaped object, with a tail about six times as long as the head, going in a northerly direction. The head was of dazzling brightness, having the appearance of the electric light, and changing to a golden shade before it vanished. As I watched the object the tail suddenly broke in two, leaving the pear-shaped head and part of the tail separate; then the broken tail seemed to rush into the head, and drop out of sight. Before I saw the object, and all the time I was watching it, which could only have been for three or four seconds, I distinctly heard a rushing sound. I first saw the meteor when directly over my head, and it disappeared at an angle of 10° from the N. horizon."

Herr Boeddicker, of Lord Rosse's observatory, Birr, writes to the *Irish Times* of April 27th as follows:—"My attention has been drawn to numerous letters concerning a rumbling sound heard over East Tyrone, and ascribed by various writers either to a meteor or an earthquake. That the former explanation is the true one is established beyond a doubt by the fact that Master R. FitzMaurice, of Carlow, saw the meteor at the same time, viz., 10h. 30m. (Dublin time). It flashed into sight in the N.E. in full sunlight, and left a long train behind."

With regard to the strange sound, the Rev. E. F. Campbell, of Moy, says it occurred at 10h. 30m. (Dublin time), and that he was standing talking to his gardener at the time. The morning was perfectly still, the sun shining, and mist rising. "The sound seemed to be very deep in the heavens; to the east it appeared to be far above thunder distance, and about half as loud. It lasted from 30 to 60 seconds, and I can only describe it as being like the whirring of a very large motor with a deep tone. I looked steadily at the point it seemed to come from, but could see nothing, possibly, or probably, owing to the thin rising mist." The Rev. E. F. Hutching-, of Market Hill, Co. Armagh, says "that a great rumbling sound was heard there on Thursday, April 10th, at about 11 o'clock a m. (Dublin time), and lasted about eight seconds. I have no doubt whatever but that it was of seismal origin, it being a full round booming sound, pervaded by a regular wavy rumbling. There was an absence of any crashing, detonating, or rippling sound, such as more or less distinguishes the explosion of meteorolites. There was no tremor in the ground or air that I could perceive, but a boy of eleven years, working in a garden when he heard the sound, ran and said the garden was shaking."

There appears to be no doubt, however, that from the near correspondence in time between the rumbling sound and the visible disruption of the fireball, that the whole phenomenon was meteoric. It will be interesting to hear of further observations of the fireball, which seems to have been a particularly brilliant object, even in the presence of the sun, over the north-east region of Ireland. As seen from Dunsink, the meteor disappeared at an estimated altitude of 10°, and if its position was then over Tyrone, in the neighbourhood of Dungannon, its height must have been 15 miles. The probable radiant point would be in Pegasus, near β Piscium, or in the eastern region of Aquarius if the direction of the fireball's flight was from the zenith to near the northern horizon, as observed at Dunsink.

LARGE METEOR.—Mr. G. Fisk, of Eccleshill, Bradford, writes that he observed a meteor brighter than Venus on April 20th, 10h. 42m. It appeared to shoot from near α Draconis, and disappeared near γ Ursae Minoris. It was intensely blue in colour, and cast a distinct shadow, though the moon was almost at full. Duration of flight, about $1\frac{1}{2}$ seconds. It left very little trail. This meteor, though it appeared on the date when Lyrids are unusually numerous, was directed from the region of ζ Ursae Majoris and α Canum Venaticorum, so that it could not have belonged to the periodical shower of April.

THE FACE OF THE SKY FOR JUNE.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.51 A.M., and sets at 8.4 P.M. On the 30th he rises at 3.48 A.M., and sets at 8.19 P.M.

Summer commences on the 22nd, when the sun is at the solstice, on which date he remains above the horizon for 16h. 35m.

Sunspots are infrequent; at the time of writing the sun's disc is devoid of spots.

THE MOON:—

	Phases.	h. m.
June 6	● New Moon	6 11 A.M.
„ 12	☽ First Quarter	11 54 P.M.
„ 21	○ Full Moon	2 17 A.M.
„ 28	☾ Last Quarter	9 52 P.M.
		h.
June 6	☾ Perigee	5·2 A.M.
„ 19	☾ Apogee	4·9 P.M.

The following are the particulars of stars occulted during the month and observable at convenient hours:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h
June 15	86 Virginis	6·0	10 15 P.M.	110	89	11 31 P.M.	285	255	9 17
„ 18	ρ Scorpii	4·5	9 37 P.M.	118	125	10 59 P.M.	261	255	12 16
„ 21	D.M.–19°5134	6·5	9 7 P.M.	92	122	10 23 P.M.	264	285	15 16

THE PLANETS.—Mercury is an evening star, and during the early part of the month is fairly well placed for observation. On the 1st he sets due N.W. shortly after 10 P.M., or two hours after the sun. On the 10th he sets at 9.25 P.M., or a little more than an hour after sunset. He is at the stationary point on the 11th, in aphelion on the 18th, and in inferior conjunction with the sun on the 23rd.

Venus is a morning star, but is not very well suited for observation as her brightness is diminishing. About the middle of the month she rises in the E.N.E. shortly before 2 A.M.

Mars is also a morning star, but does not lend itself to easy observation as he only rises in the early dawn about an hour in advance of the sun.

Jupiter is still in Capricornus, and is becoming more accessible for observing purposes. About the middle of the month he rises shortly after 11 P.M., and comes to the meridian about 4 A.M. The apparent diameter of the planet is increasing, being 39″·6 on the 1st, and 43″·0 on the 30th. He is stationary on the 6th, after which he describes a retrograde path, thus accelerating his diurnal return to the meridian.

Uranus is visible throughout the night, rising about 8.45 P.M. on the 1st, and about 6.40 on the 30th. He is in opposition on the 11th. The planet is situated a little north of θ Ophiuchi, as is shown by the chart below, which should enable it to be found readily. It shines with the brightness of a 6th magnitude star, and can be made out on clear moonless nights with the naked eye, but, aided by a pair of opera-glasses, it is easily discernible.

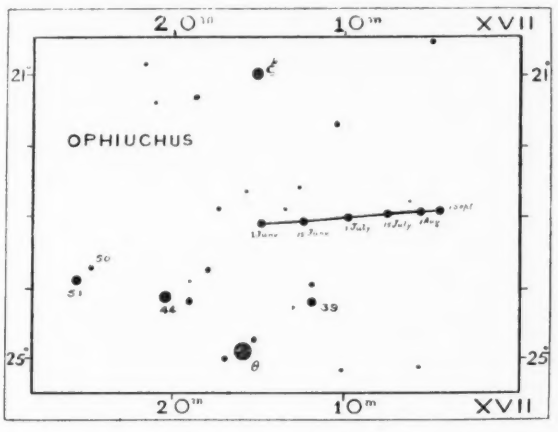


Chart showing Path of Uranus

Saturn is becoming more favourably situated for observation. During the month the planet describes a short westerly path in Sagittarius, near the border of Capricornus. On the 1st he rises at 11.10 P.M. and transits at 3.23 A.M., whilst on the 30th he rises at 9.10 P.M. and souths at 1.22 A.M. The apparent diameter of the planet is 16″·8, whilst the major and minor axes are 42″·0 and 15″·5 respectively.

Neptune is not observable, being in conjunction with the sun on the 23rd.

THE STARS.—Position of the stars about 10 P.M.:—

ZENITH . Great Bear, Cor Caroli.
NORTH . Ursa Minor, Cepheus, Cassiopeia.
EAST . Cygnus, Lyra, Aquila, Sagittarius.
SOUTH . Hercules, Ophiuchus, Corona, Libra, Scorpio.
WEST . Leo, Cancer.—S.W.: Virgo and Bootis.—N.W.: Capella.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of May Problems.

No. 1.

"Per Aspera ad Ardua."

Key-move.—1. Q to R6.

If 1. . . . K to B4, 2. Q to R5ch, etc.
1. . . . K to Q5, 2. Q to B6ch, etc.
1. . . . B to B5, 2. Q to Kt7ch, etc.
1. . . . P to B7, etc. 2. Q to Kt5ch, etc.
1. . . . R to Rsq, ch, 2. P × R(Q) ch, etc.
1. . . . Kt to B6, etc. 2. R to K2ch, etc.

[There is a dual after 1. . . Kt to K7 by 2. R × Ktch, or 2. Q to Kt5ch.]

No. 2.

"Fort Nachanand."

The author's solution is 1. Kt to R5, but this fine problem is unfortunately cooked by Q to R5ch.

No. 3.

"Algol."

Key-move.—1. P to Q4ch.

If 1. . . . K to Q4, 2. Kt to K7ch, etc.
1. . . . K to Kt4, 2. Q to QKt7ch, etc.
1. . . . K × Kt (B5), 2. B to Kt3ch, etc.
1. . . . K × Kt (B3), 2. B to R4ch, etc.

[A near 'try' by 1. B to R4 is defeated by 1. B to K4].

SOLUTIONS received from W. Nash, 5, 6, 4; Alpha, 4, 0, 0; W. Jay, 5, 6, 4; G. Woodcock, 4, 4, 4; G. W. Middleton, 5, 4, 3; "Endirby," 5, 4, 4; W. de P. Crousaz, 4, 4, 4; G. A. Forde (Captain), 0, 0, 0; W. J. Land, 0, 4, 0; J. Y. Fullerton, 4, 4, 0; "Tamen," 5, 0, 4; "Cowslip," 5, 4, 4; J. Sowden, 4, 4, 0; C. Johnston, 4, 4, 4; "Looker-on," 5, 3, 4; A. F. (Rugby), 0, 0, 0; H. D'O. Bernard, 5, 4, 4; J. W. Dawson, 4, 4, 4; H. Boyes, 4, 4, 0.

It is possible that some solutions may have gone astray, and may be received after this page has gone to press. It would save much trouble in going through solutions if correspondents would refrain from the complete analysis which some appear to think necessary. Post-cards are preferred, and duals and claims for second solutions should be clearly indicated. Some solvers have sent in claims for duals on the third move, but these, under the conditions, do not count.

Composers of "Leonard" and "All's well that ends well."—Corrections received, and will be made accordingly.

Norseman.—April solutions correct, but too late to acknowledge.

Composer of "Vega."—Since you have sent your name and address it would be impossible to insert the problem.

G. S. Johnson.—As pointed out in my reply to you last month, a problem cannot be admitted to the tournament when the conditions as to sealed name and address have not been observed. Nor could any correction be received in the case of a problem which has been shown in this column to be unsound.

H. D'O. Bernard.—In the circumstances I think that your solutions may be accepted for this occasion.

G. F. Todd.—I fear that your solutions were too late to be counted.

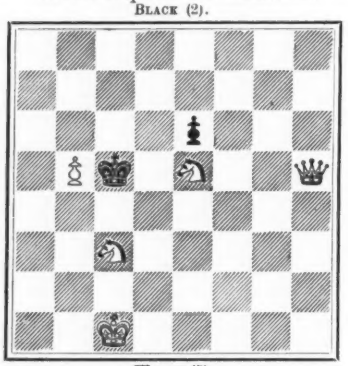
Alpha.—Your revised solution of No. 3 is quite correct, but too late, as you say, to count. I quite understand that you are not a serious competitor, but solutions must be acknowledged on a uniform system.

PROBLEMS.

No. 4.

"Three steps and a shuffle off."

BLACK (2).



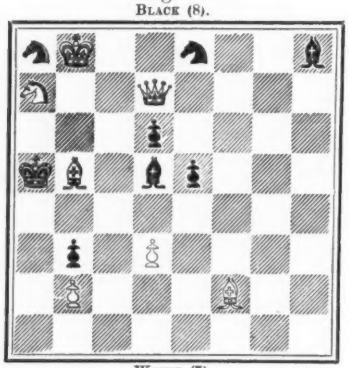
WHITE (5).

White mates in three moves.

No. 5.

"Englisch."

BLACK (8).



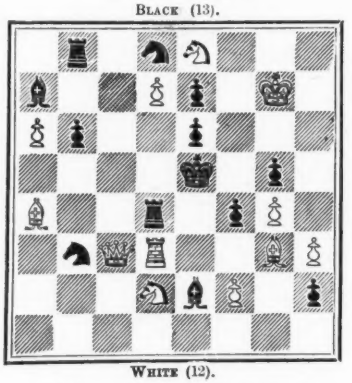
WHITE (7)

White mates in three moves.

No. 6.

"Trifolium Duplex."

BLACK (13).



WHITE (12).

White mates in three moves.

CHESS INTELLIGENCE.

A match between Scotland and the Northern Counties was played last month at Manchester, with twenty-two players on each side. Scotland were defeated by 15½ games to 6½.

The Cable Match between the American Universities and a combined Oxford and Cambridge team resulted in a rather easy victory for the Americans, the score being as under:—

U.S.A.		ENGLAND.	
C. T. Rice (Harvard)	1	H. A. Webb (Cambridge) ...	0
F. H. Sewall (Columbia) ...	1	W. M. Grundy (Oxford) ...	0
J. F. Sawin (Yale)	1	H. F. Davidson (Oxford) ...	0
J. B. Hunt (Princeton) ...	1	F. W. Clarke (Cambridge) ...	0
H. A. Keeler (Columbia) ...	½	H. Bateman (Cambridge) ...	½
J. Adams (Yale)	0	H. D. Roome (Oxford)... ...	1
	4½		1½

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